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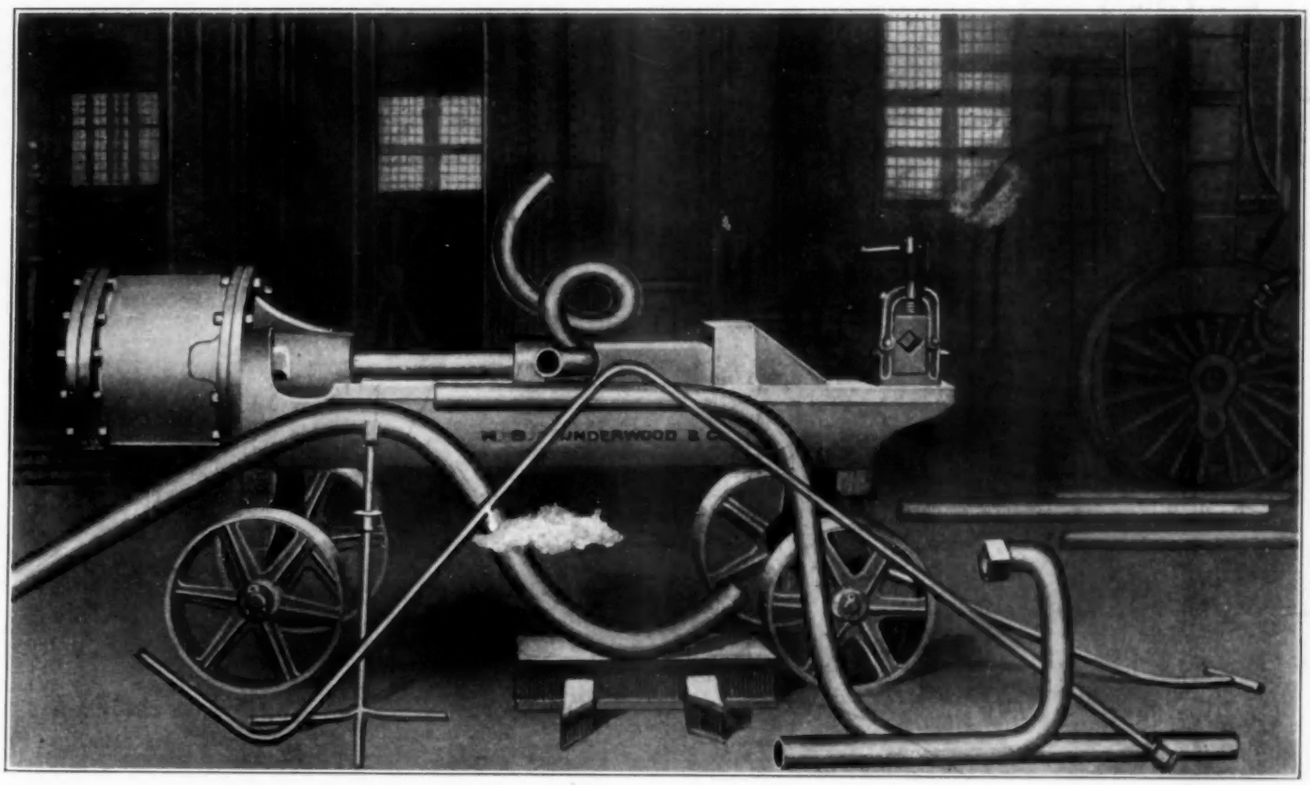
Vol. 31. No. 5.

Index to Advertisers and Classified Index Following Reading Matter.

THE UNDERWOOD PNEUMATIC PIPE BENDING MACHINE



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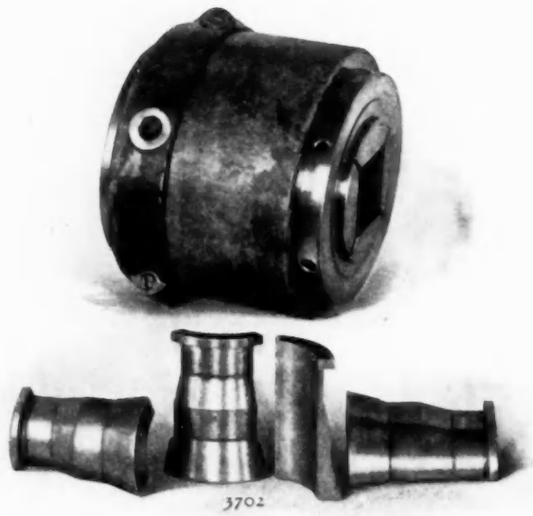

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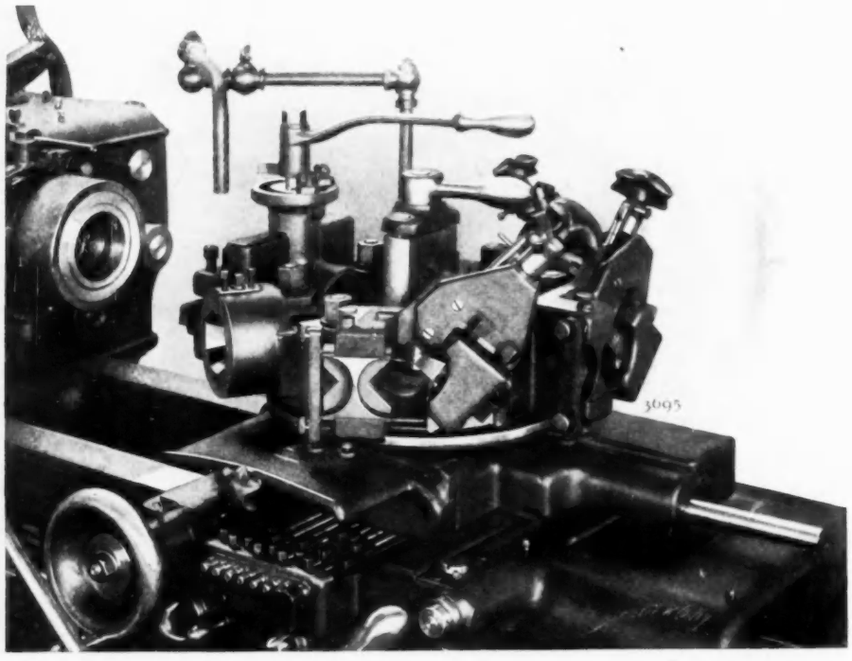

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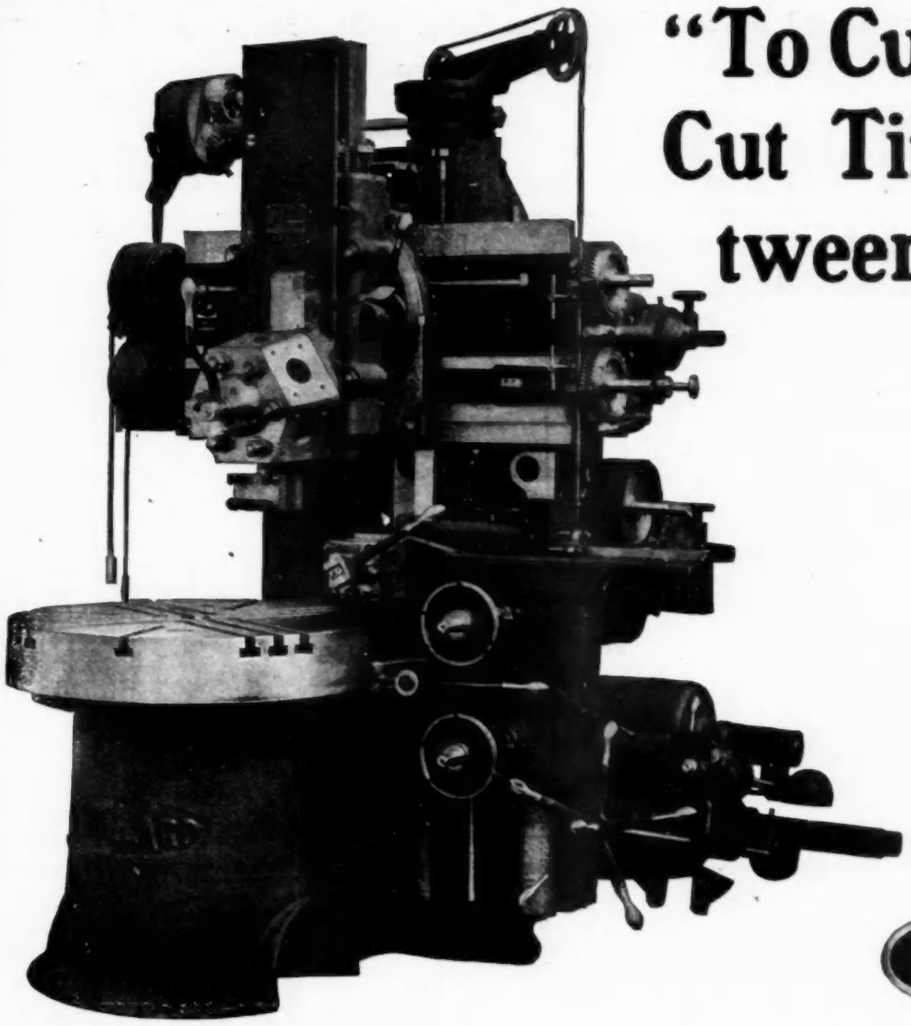

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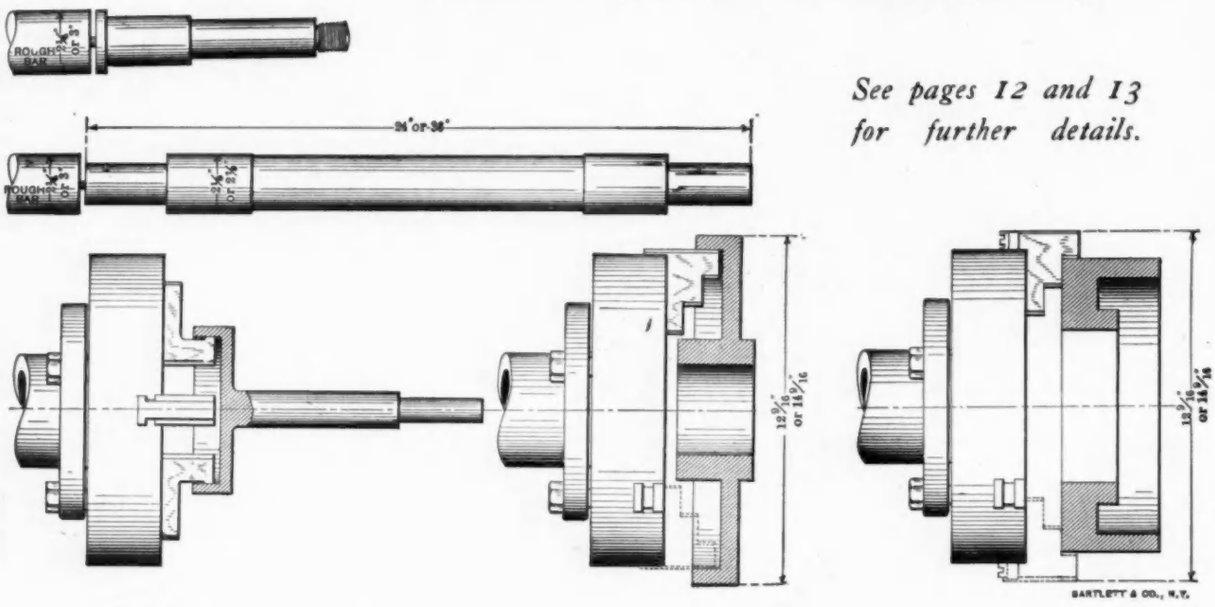

See pages 12 and 13 for further details.

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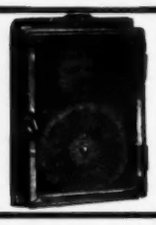

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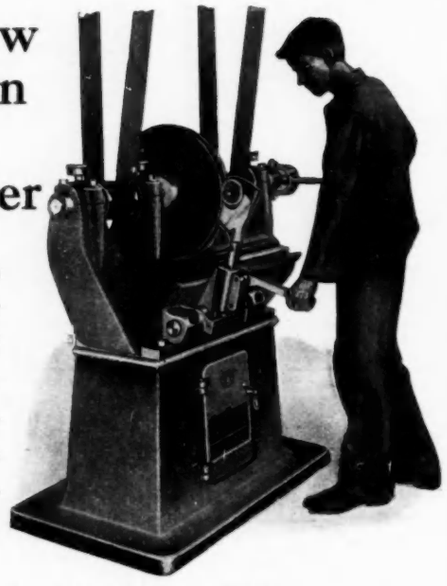

which covers a wider range of work than is usually attained in this class of machine.

It Practically Never Wears Out

and can be relied on for accurately finishing small parts of machinery at a rapid rate.

Skilled labor is not necessary to get profitable results on this machine.

Circular sent on application

Diamond Machine Company,
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Fuel Oil for General Shop-furnace Use

Construction and Performance of Furnaces Successfully and Economically Fired with Oil at the Mare Island Navy Yard

BY HOLDEN A. EVANS*

Owing to the high cost of coal on the Pacific coast and to the abundant supply of crude oil, the development of oil as fuel is perhaps greater there than in other parts of the country. The use of oil as a fuel has been rapidly extended in the last few years and much progress has been made in oil-burning appliances. In the construction and repair department at the Mare Island navy yard oil is extensively used for many purposes, and a description of the various installations will undoubtedly be of interest and value to the readers of the AMERICAN MACHINIST.

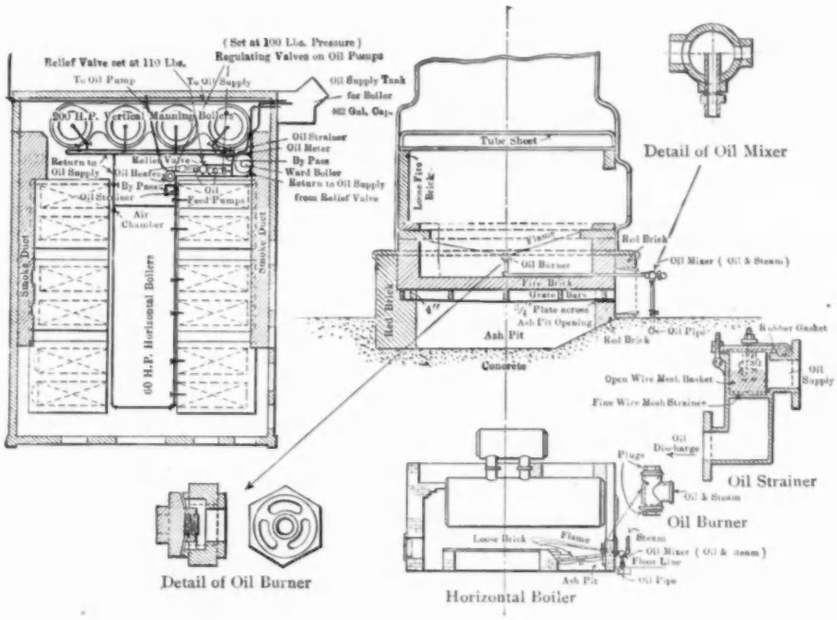


FIG. 1. OIL BURNERS, STRAINERS AND PIPING FOR BOILER PLANT

Oil fuel is successfully used in this department for the following purposes: Main boiler plant; shipsmith shop, both for furnaces and open forges; galvanizing pots; coppersmith forges; sabining pots; plate and angle furnaces; brass furnaces; annealing oven; core oven; annealing armor; various portable furnaces; melting pig iron in the foundry.

Storage Tanks and Supply Mains

The main supply tanks are located on a hill several hundred feet from the shops and at an elevation of about 40 feet above their level. There are two tanks, each 40 feet in diameter, and their combined capacity is 54,800 gallons. In addition to these, there are near the shops two smaller reserve tanks, each of 13,200 gallons capacity, which can be used in case of repairs to the pipe line from the main tanks. These reserve tanks are buried in the ground and are thus free from danger. The main tanks are filled by means of a 6-inch pipe line from the water front, where the oil is delivered in tank barges and whence it is pumped. From the main tanks the oil is delivered by gravity to the reserve tanks and the small auxiliary tanks. The delivery pipe from the main tanks is 5 inches in diameter and is fitted inside with a ½-inch steam pipe running its entire length for heating the oil in cold weather so that it will flow freely. The daily consumption of oil is about 5000 gallons, so that there is a maximum storage supply for about 15 days.

Character of the Oil

Oil is purchased under the following specifications:

"Oil to test between 14 degrees and 20 degrees gravity by Baumé hydrometer at a temperature of 60 degrees Fahrenheit. Water and sediment not to exceed 2 per cent. To be best quality for fuel purposes; flash point to be not less than 140 degrees Fahrenheit. Oil shall be homogeneous throughout; that is, same kind, same gravity. To be delivered on suitable tank barges by the contractors, and by them pumped into the construction and repair tanks at the navy yard, Mare Island, Cal. Deliveries to be made within 10 days from receipt of notice in quantities of from 2000 to 5000 barrels, as may be required by the naval constructor. The tanks are connected with the quay wall with a 6-inch pipe line having 6-inch standard coupling, which is available for connection with the tank barge."

A yearly contract is executed and deliveries are made as required. Previous to the present year the purchase price has been very low, but in the last year there has been a sharp advance in the price and it is doubtful if the price will ever go as low as it was last year. It is probable that in the future the cost will be around one dollar per barrel. The contract prices for the past two years and the present year are as follows: July 1, 1905, to July 1, 1906, 1.14 cents per gallon; July 1, 1906, to July 1, 1907, 1 cent per gallon; July 1, 1907, to July 1, 1908, 2.06 cents per gallon.

Main Boiler Plant

The main boiler plant consists of four vertical Manning boilers of 200 horsepower each, carrying a working pressure of 115 pounds, and 12 horizontal return-tubular boilers, each of 60 horsepower rating and having a working pressure of 80 pounds. The Manning boilers are modern, but the 12 horizontal boilers were built years ago for the dry-dock pumping plant. The main power plant, consisting of the electric generators and the air compressors, takes steam at 115 pounds pressure from the Manning boilers. One of the old boilers supplies steam at 80 pounds pressure to the blacksmith shop for the hammers and for heating purposes, while the remaining boilers are used only when required for running the dry-dock pumps.

The general arrangement and details of the oil piping and burners are shown by Fig. 1.

A small auxiliary tank of 462 gallons capacity is located just outside the boiler room. This is supplied from the 5-inch delivery main from the main supply tanks, the supply being controlled by a float valve. The oil is pumped from this tank by steam pumps which are automatically controlled by a Foster Engineering Company regulating valve (Fig. 2) and is delivered to the burners under 100 pounds pressure. The oil is atomized by steam at the boiler pressure. A small Ward boiler, burning coal, is used for supplying steam for the oil pumps and for

*Naval constructor, United States Navy.

atomizing while raising steam on the main boilers. When the oil-burning installation was first made, commercial patented burners were used; but it was found they were not entirely suited to the type of boilers used and after some experience the type of burners shown was developed and installed. It will be seen that there is both a mixer and an atomizer, and that one type of atomizer or burner is used for the vertical boilers, while another type is used for the horizontal boilers.

When first installed a straight-away burner was used, and this was placed at about the hight of the center of the furnace door. This brought the flame too near the tube sheet, and some difficulty was experienced with leaky tubes; it was found that the beading on the tubes was being burned. A rose burner was then developed and this was placed considerably lower — through the ash-pan doors, as shown in Fig. 1. Owing to the length of piping from the ash-pan door to the burner, which was subjected to high heat, it was expected that there would be a large carbon deposit which would soon clog the burner and pipe. This did not prove to be the case, for absolutely no trouble has been experienced. When the piping was taken down for examination after several months' trial, it was found to be perfectly clean. It is probable that carbon is deposited in small particles, but it is immediately forced out by the steam. This type of burner seems to be particularly well suited to the vertical type of boiler and most excellent results have been obtained. The character of the brickwork in both types of boilers is clearly shown in Fig. 1. A simple strainer is fitted between the pumps and the burners, the details also being shown in Fig. 1. A by-pass is fitted around each strainer so that the basket in the strainer can be readily and frequently cleaned without interrupting the supply of oil.

It will be noted from Fig. 1 that the delivery pipes from the pumps, after supplying the burners, lead back to the tanks, so that the cold oil remaining in the pipes over night can be forced back into the tanks and the oil can be circulated through the heater until a temperature of 120 degrees Fahrenheit is obtained before the time for starting the fires. When this is done, the valve in the return pipe is closed. It will also be noted that there is a reserve supply of oil available in the tanks located near the shops. This insures against a shut-down in case of a break in the main supply line and also allows the auxiliary tank to be cleaned during working hours.

The average consumption of oil for each 200 horse-power Manning boiler is 65 gallons per hour, and the rate of evaporation is 13 pounds of water per pound of oil.

Fuel Oil in the Blacksmith Shop

In the blacksmith shop there are one double-door reverberatory furnace, several medium-sized furnaces, several small furnaces for the bulldozer, bolt machines and rivet machines, and a large number of open forges.

From a number of experiments, extending over a period of nearly two years, with pressures for atomizing and combustion varying from 6 ounces air blast to 90 pounds air and steam pressure, it is found that for open forges an air pressure of 4½ to 5 pounds is the most satisfactory—if but one pressure is available. If both an air blast of 6 to 8 ounces and a 4½-pound air pressure are available, equally satisfactory results are obtained by using the pressure for atomizing and the blast for combustion. This combination is probably more economical than when using the 4½-pound air pressure for both atomizing and combustion.

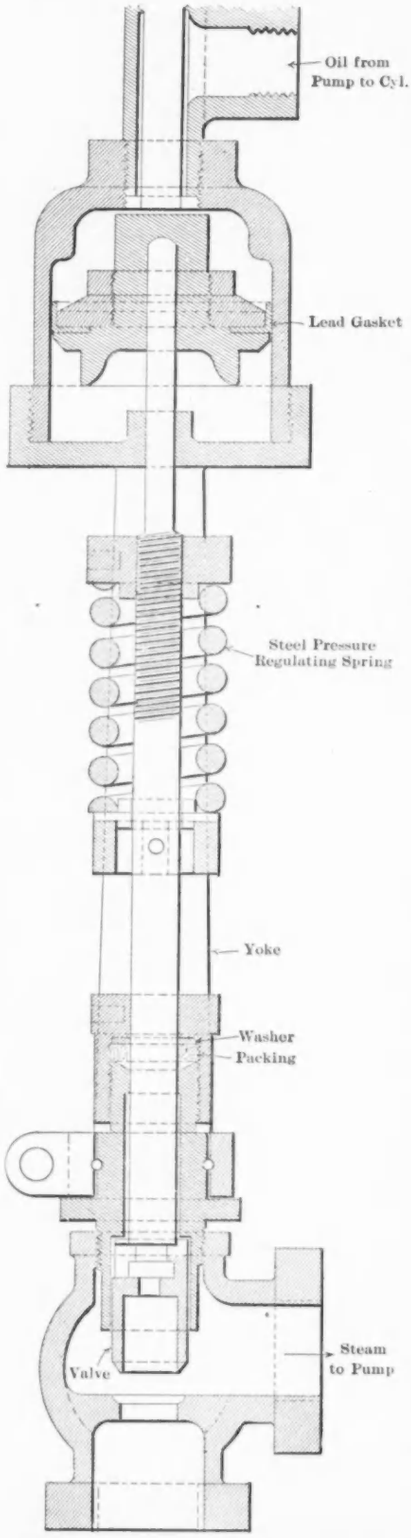


FIG. 2. REGULATING VALVE ON OIL PUMPS

In developing a satisfactory open blacksmith forge many experiments were necessary. While oil has been used in furnaces for a long time, its use had never been attempted in an open forge; even now, until recently, there are very few shops where it is so used. It is not generally known that it can be successfully used for this purpose. Experiments were begun in the construction and repair shops at Mare Island three years ago, and it is believed that this was the first shop in the world entirely to discard coal and use oil instead.

After using various types of burners with more or less success, it was found that the *best* type of burner was *no burner at all.* One of the principal difficulties was in keeping the burners clear when using low pressure for atomizing, as the carbon deposits soon choked the passages. This difficulty was overcome by doing away with the burner and using instead a rotary mixer located alongside the forge and well away from its intense heat. There is shown in Fig. 3 the type of forge used, with the details of the piping.

A Rotary Oil and Air Mixer

Fig. 4 shows the details of the rotary mixer. It consists of a small wheel mounted in a cast casing with an inlet at the top for air at 4½ pounds pressure and a discharge opposite. The oil under pressure enters at the bottom. The air pressure drives the small wheel at a high speed and this breaks up the oil into minute particles and discharges the mixture of oil and air through a 1¼-inch pipe into the forge.

Valves for regulating the oil and air are easily accessible and the proper combination is readily obtained. Too much oil immediately shows in the smoking of the fire, while too much air reduces the temperature of the fire. When the oil pressure and air pressure are both regular, which is highly desirable, the fire once regulated needs but little attention. It can be regulated to give either a forging heat or a white welding heat, according to the work. It will be noted that only a comparatively small amount of oil enters the mixer; for this reason it is possible for this mixing wheel, which revolves at a considerable speed, to break up the oil into fine particles. The pipe leading from the mixer to the forge is 1¼ inches and is, therefore, large enough

to prevent carbon deposits from choking it. However, after five to six months' use considerable carbon will be found deposited, and it is well to clean the pipes twice a year.

The air pipes leading from the 4½-pound line across the front of the forge are to keep the flame from the smith, and without it a man can do but little work, as the heat is very intense. Blast pressure was tried for this purpose, but when atomizing at 4½ pounds pressure the blast could not control the flame and it was necessary to use the higher pressure. Fig. 5 shows the arrangement used when air at 4½ pounds pressure is used for atomizing and the blast pressure for combustion. With this arrangement the valve on the 4½-pound line is nearly closed, only enough air being used for

(a) Both the oil pressure and the air pressure must be uniform.

(b) The oil must be uniformly heated, the temperature depending on its gravity.

(c) The water must be removed from the oil.

(d) There should be no dead pipes which will allow the oil in them to fall below the required temperature. In other words the oil-supply pipe should form a circuit so that all surplus oil can be returned to the supply tank.

(e) The oil in the auxiliary supply tank and supply pipes should be uniformly heated before the hour for beginning work in the shop.

In the shops under my supervision all of these conditions were not met when the installation was first made, and the necessity for fulfilling all of the conditions enumerated has been learned by experience. In the installation as first made, the oil-supply pipe did not form a circuit and local heaters were depended upon to give the required temperature. One of these, a large one, was placed in the pump suction; another was placed at the entrance of the supply pipe to the shop and two others were distributed in the shops. This seemed ample, but difficulties were immediately encountered. In the first place it was found difficult to keep the temperatures of the various heaters uniform. For the oil used, 15 to 20 degrees gravity, the temperature should be kept at from 115 to 120 degrees Fahrenheit. Inspections of the heaters showed variations from 90 to 160 degrees. One man was getting his oil so cold that it would not atomize, while another was getting his too hot. The placing of a heater at each fire was then considered; but this was rejected, not only on account of the expense and disadvantage of long leads of small steam piping, but because it was felt that the great majority of the men would not regulate their heaters and keep the oil at the temperature desired.

Another trouble experienced was that when a fire not in use near the end of the line was started it was necessary to get rid of the cold oil lying in the dead pipe before a satisfactory fire could be secured. Considerable difficulty was also experienced in starting fires in the shop in the mornings on account of the cold oil. It is not pleasant for a manager to visit his shop 20 minutes after starting time and find it full of smoke, with everyone from the foreman to the apprentice disgusted, and not a fire started. This was my experience on many mornings; as I was personally responsible for the installation, which had been made against the wishes of practically every man in the shop, my path for a few weeks was not an easy one.

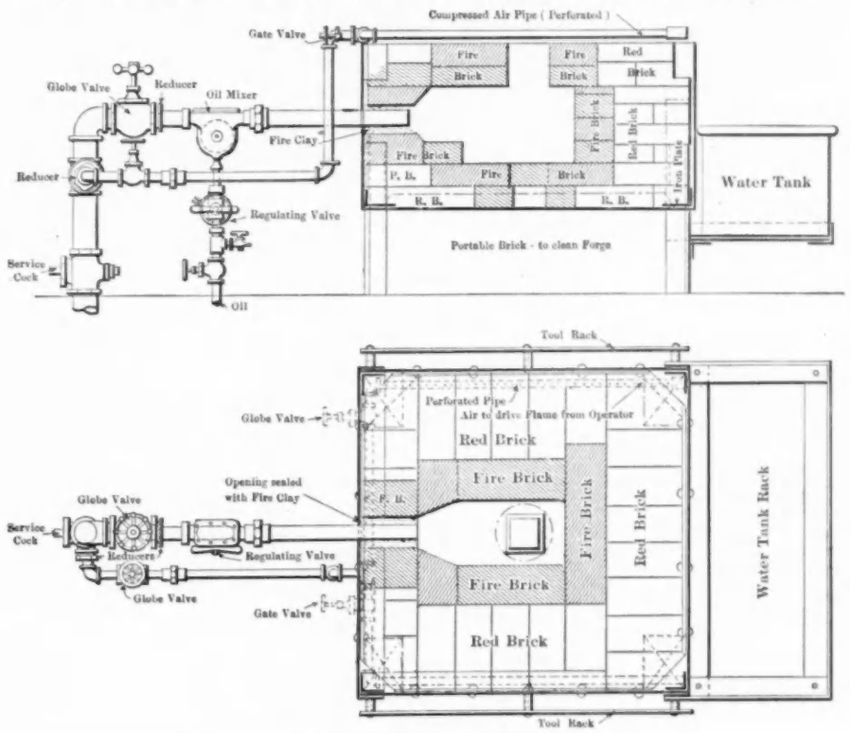


FIG. 3. FUEL-OIL FIRED FORGE

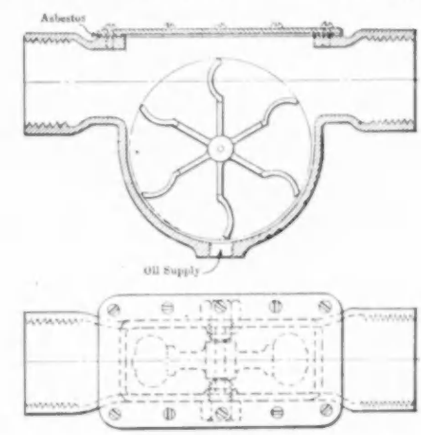


FIG. 4

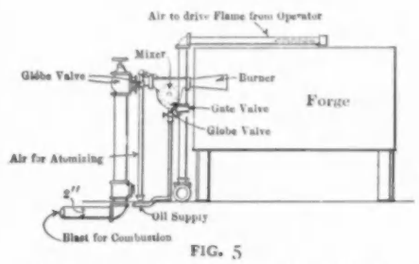


FIG. 5

ROTARY MIXER AND ITS APPLICATION TO A FORGE

revolving the wheel. The 6-ounce air blast supplies the necessary oxygen for combustion.

Two forges were operated for several weeks with 6 to 8 ounces air both for atomizing and combustion, with fairly good results; but these were not as satisfactory as the forges atomizing at 4½-pounds pressure. As the higher pressure was available, the use of low pressure for atomizing was discontinued. There is no doubt that a satisfactory blast-pressure forge can be easily developed; in small shops where the first cost of a positive blower cannot readily be met, the blast-pressure forge will have a field of its own.

Importance of the Oil Supply

The oil supply is important; unless the following conditions are met, difficulties will be experienced with the forges.

Another fault of the installation as first made was that adequate provision had not been made for getting the water out of the oil. The settling of the water and drawing it off in the main tanks was at first considered sufficient, but after seeing practically every fire in the shop, some of which were engaged on important welds, put out by water it was decided that this was not adequate.

Other Difficulties

The difficulties enumerated were due to faults of installation; there is, however, another difficulty which probably every

manager encounters when he attempts to introduce some radical improvement, that is, the opposition of his workmen. In the case of the oil installation the opposition was very strong. It was probably due to two causes, one, the natural conservatism of workmen; the other, that the heats were taken in very much less time and it gave the men less time to stand around and wait. In other words the use of oil made the men work harder.

Every possible objection was advanced: First, that good work could not be done in an oil fire, and that it would be impossible to make good welds — for some weeks every bad job that was turned out was due to the oil; second, that the white heat would blind the men—one man quit because he feared if he remained a few weeks longer he would be wholly blind; third, that the noise of the air made the men deaf and nervous. Never, however, was the excuse made that the men would have to do more work! This difficulty was overcome by getting a reliable man who did take an interest in the improvements, putting him at an oil fire and letting him work at this fire for several weeks, doing every class of work that is done in the shop. After this was done, all the coal fires were removed, oil fires installed and the men were informed that they would work at them and do good work or go somewhere else. At the present time it is not believed that there is a man among them that would go back to the soot and grime of the coal fire.

Some of the new men, however, particularly Eastern anglesmiths, who know nothing about burning oil, still prefer the coal fire. This is due to the fact that they have been doing anglework in coal fires for 15 to 25 years and know exactly what they can do and what they can earn (at piece-work), and they do not wish to experiment or to learn while working piece-work. Also to the fact that anglework is the most difficult work for an oil fire, and of all classes of smithwork it is less suited to oil than any other. It is believed, however, that in six months' time these men will prefer the oil-fired forge.

Arrangement of the Apparatus

The difficulties encountered have been entirely overcome and the old installation is now an unqualified success. Fig. 6 shows the general arrangement of the pump, heaters, auxiliary tanks, piping, etc. It must be remembered that the system as shown in Fig. 6 is not one that was laid out at first with definite ideas of what was actually required. There was no past practice to serve as a guide and, furthermore, in the experimental stage it was not thought best to go to much expense as the installation might prove a failure. For this reason piping already laid was utilized as far as possible and the leads changed as requirements made necessary. This accounts for some of the indirect leads shown.

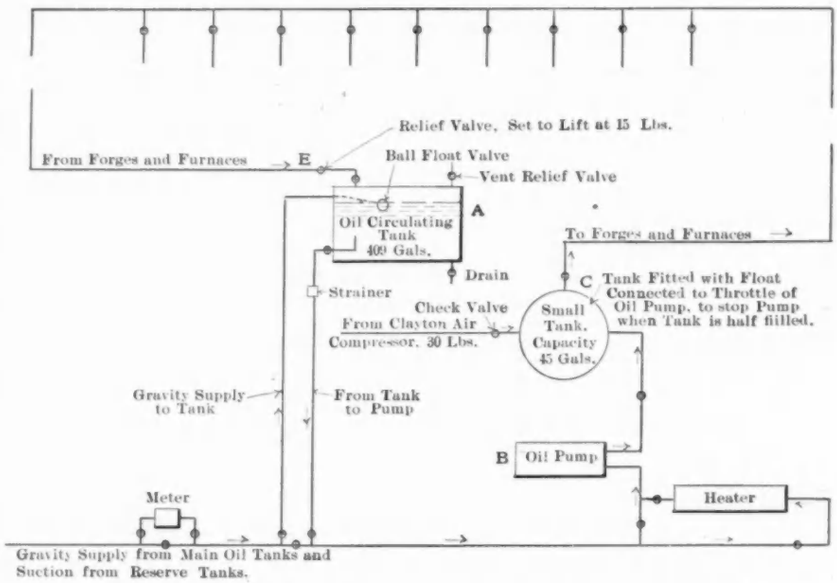

Relief Valve, Set to Lift at 15 Lbs.
From Forges and Furnaces
E
Ball Float Valve
Vent Relief Valve
A
Oil Circulating Tank 409 Gals.
To Forges and Furnaces
Drain
C Tank Fitted with Float Connected to Throttle of Oil Pump, to stop Pump when Tank is half filled.
Strainer
Check Valve
From Clayton Air Compressor, 30 Lbs.
Small Tank, Capacity 45 Gals.
Gravity Supply to Tank
From Tank to Pump
B Oil Pump
Heater
Meter
Gravity Supply from Main Oil Tanks and Suction from Reserve Tanks.

FIG. 7. RELATIVE ARRANGEMENT OF OIL CIRCUIT, TANK, PUMP, HEATER, ETC.

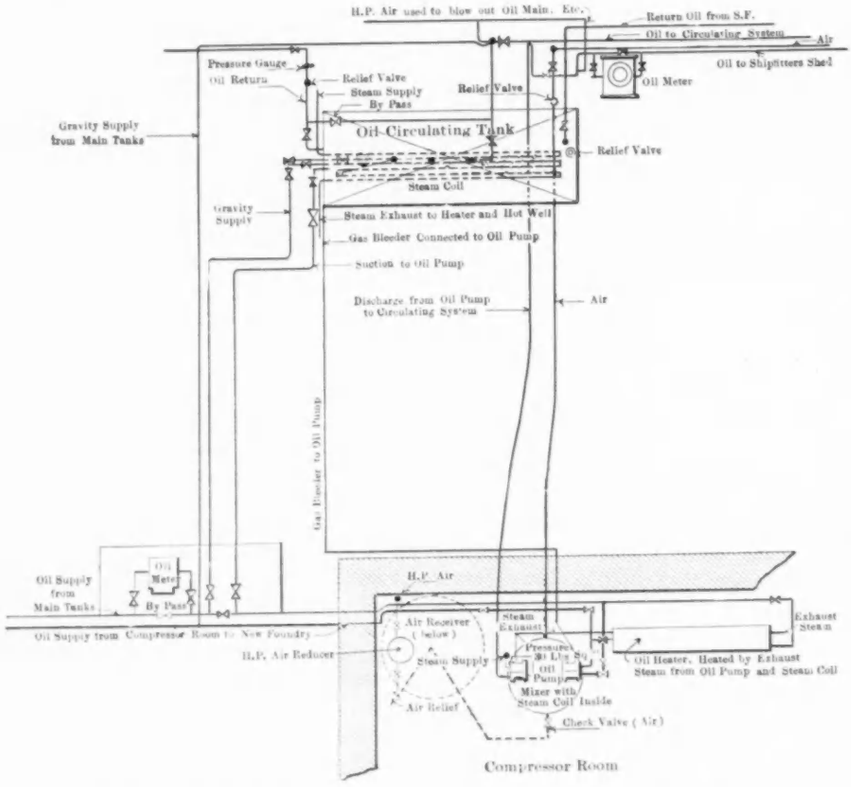


FIG. 6. PIPING FOR OIL-CIRCULATING TANK, COMPRESSOR AND PUMP

For the sake of clearness Fig. 7 shows in a diagrammatic manner the arrangement as finally installed, which has proved a success. There is an auxiliary tank of 409 gallons capacity marked *A*. This is filled from the main supply tanks by gravity. The valve in the supply line is controlled by a float in the tank so that the auxiliary tank is automatically kept about two-thirds full. In this tank there is a steam coil for heating the oil to the desired temperature of 115 to 120 degrees Fahrenheit. The tank is also fitted with a gage glass leading to the bottom. This glass shows the amount of water in the bottom of the tank and also the amount of oil. At the bottom of the tank there is a valve for drawing off the water. The tank is also fitted at the top with a vent valve weighted to five pounds for the escape of gas.

Pressure

The suction from the tank to the pump

is taken a short distance below the low level of the top of the oil, so that the pump cannot draw water (unless the tank is about half full of water). The pump *B* draws from this tank and discharges into a small tank *C*. The throttle valve for the pump is controlled by a float in tank *C*, putting a pressure of 30 pounds on the oil. The air pressure for this tank can be obtained by using a reducing valve on the high-pressure line where a pneumatic system is used. The compressor was used only because it was already installed. In the absence of air pressure pressure in the supply pipes the return circuit cannot discharge into the tank until the valve set at 15 pounds lifts. The pressure at the beginning of this circuit is 30 pounds.

There is another heater in the supply pipes at the entrance to the blacksmith

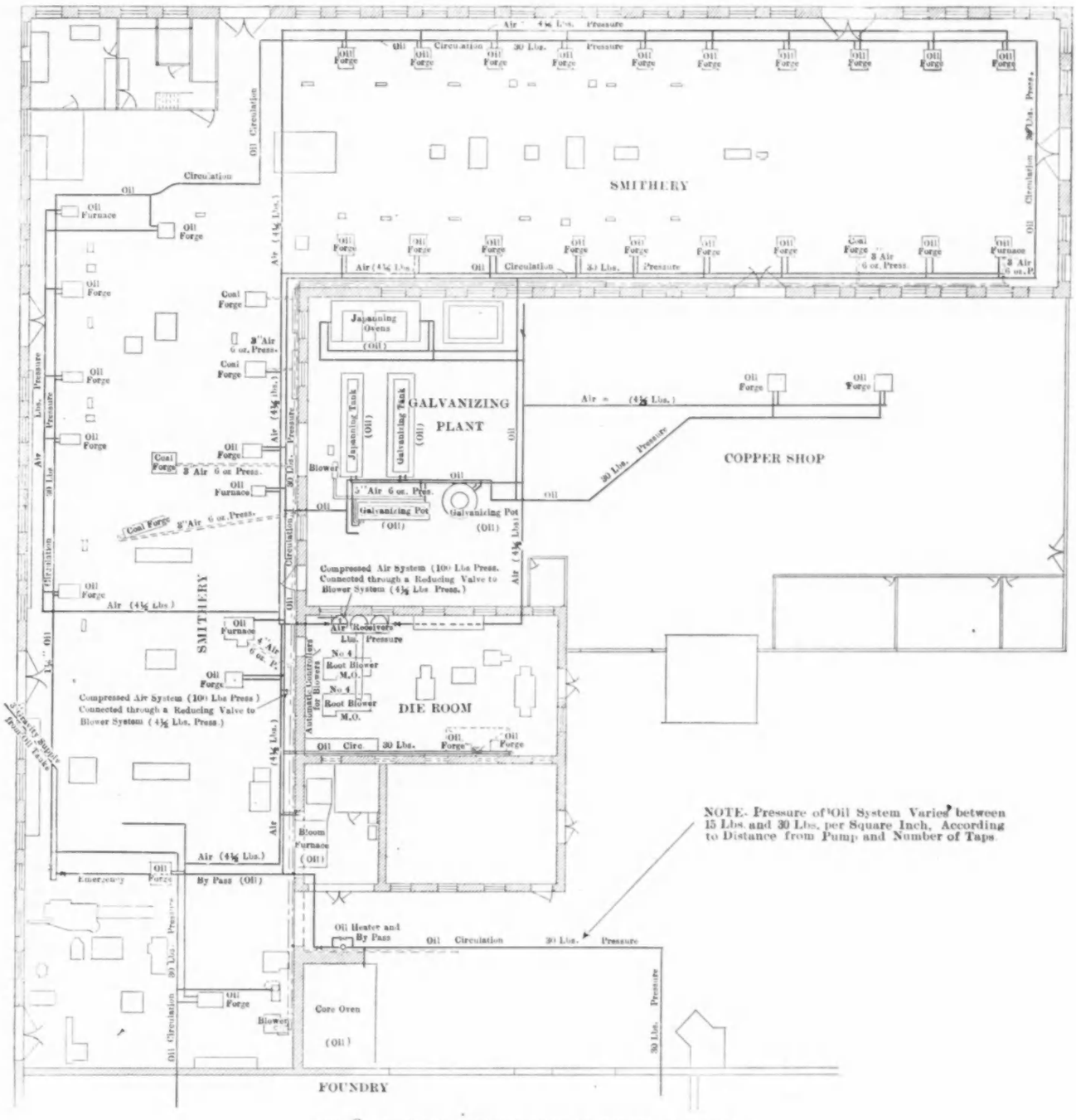

SMITHERY
GALVANIZING PLANT
COPPER SHOP
DIE ROOM
FOUNDRY
Japanning Ovens (Oil)
Galvanizing Tank (Oil)
Galvanizing Pot (Oil)
Compressed Air System (100 Lbs Press. Connected through a Reducing Valve to Blower System (4½ Lbs. Press.)
Air Receivers
Root Blower M.O.
Automatic Controllers for Blowers
Bloom Furnace (Oil)
Oil Heater and By Pass
Core Oven (Oil)
Oil Circulation
30 Lbs. Pressure
Air (4½ Lbs.)
NOTE.-Pressure of Oil System Varies between 15 Lbs. and 30 Lbs. per Square Inch, According to Distance from Pump and Number of Taps.

FIG. 8. GENERAL ARRANGEMENT OF FORGES AND PIPING

the tank *C*. The pump also has a suction from the main supply line and another from the reserve tanks so that, in case of accident to the first supply, the other two sources can be drawn from. In this suction line there is a large heater.

There is a small Clayton air compressor which has an automatic pressure control set at 30 pounds. The discharge from the compressor is led to the top of the

the oil pump itself could supply the pressure, but this would not be as uniform as with the use of air. From the tank *C* the supply mains are led the circuit of the shops, and from this circuit short leads are taken to the furnaces and forges. The main finally returns to the auxiliary tank *A* through a relief valve *E* which is set at 15 pounds. In other words, there is a complete circuit, but to control the

shop. This is to be used as a "booster" should the temperature of the oil fall in cold weather before it reaches the fires, or in case it is necessary on account of accident to draw from the reserve supply instead of from the auxiliary tank. In the morning, half an hour before work begins one of the firemen from the main boiler plant raises the relief valve *E* and starts the oil pump which draws from

the tank *A* and discharges directly back through the circuit into the same tank. The heater in the tank heats the oil, the cold oil is removed from the pipes and all is heated to a uniform temperature at starting-up time, when the relief valve is again set at 15 pounds. During the noon hour the relief valve is raised and the open circuit made until work is resumed, so that every fire will have oil at the proper temperature. The water is drawn from tank *A* as soon as any quantity shows in the glass. It will be seen that the oil system fully meets the requirements laid down as necessary for success.

The Air System

Very few difficulties have been encountered with the air system. It is supplied from two Root high-pressure positive blowers, each of which is capable of delivering 1200 cubic feet of air per minute at 6 pounds pressure. Each of these blowers is driven by a 40-horse-power direct-connected, direct-current, variable-speed, 220-volt motor. In practice it was found that 4½ pounds pressure gave excellent results, and the blowers are run at this pressure.

The pressure is automatically maintained by means of regulators made by the Mason Regulator Company, Boston, Mass., for the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. The device consists essentially of a weighted lever supported on knife edges and actuated by a diaphragm, under which air is admitted through a pipe from the receiver in which the pressure is to be regulated. This lever is connected to a double-acting piston valve which alternately opens and closes the inlet and exhaust ports through which the air passes. A piston in this cylinder is connected through the piston rod with a rack, and a gear meshing with this rack actuates a rheostat in the shunt field of the motor. When the receiver pressure rises, the diaphragm lifts the weighted lever which operates the double-acting valve, thereby opening the exhaust port at one end of the cylinder and admitting air pressure to the other end; the resulting motion of the piston moves the rheostat arm and reduces the resistance in series with the shunt field of the motor, thereby reducing the motor speed. When the pressure in the receiver drops, the reverse action takes place and the speed of the motor is increased.

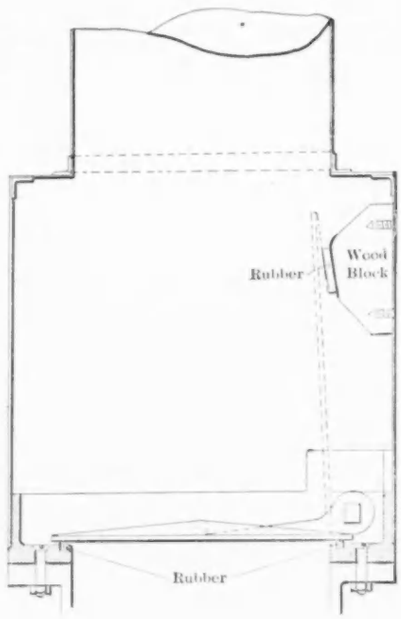


FIG. 9. AUTOMATIC RELIEF VALVE FOR BLOWERS

Fig. 8 shows the arrangement of the piping and blowers. The arrangement of the piping is not ideal, but when the installation was made it was found that considerable piping which had been run some years ago for a gas plant could be utilized and thereby greatly reduce the cost of installation. The reservoir tanks shown also formed a part of the same system. These tanks, while desirable in assisting to maintain a steady air pressure at the fires, are not considered as necessary to the success of the system.

With a two-blower system a check valve is necessary in the discharge of each blower. This was overlooked when the installation was first made and difficulty was encountered in shifting from one

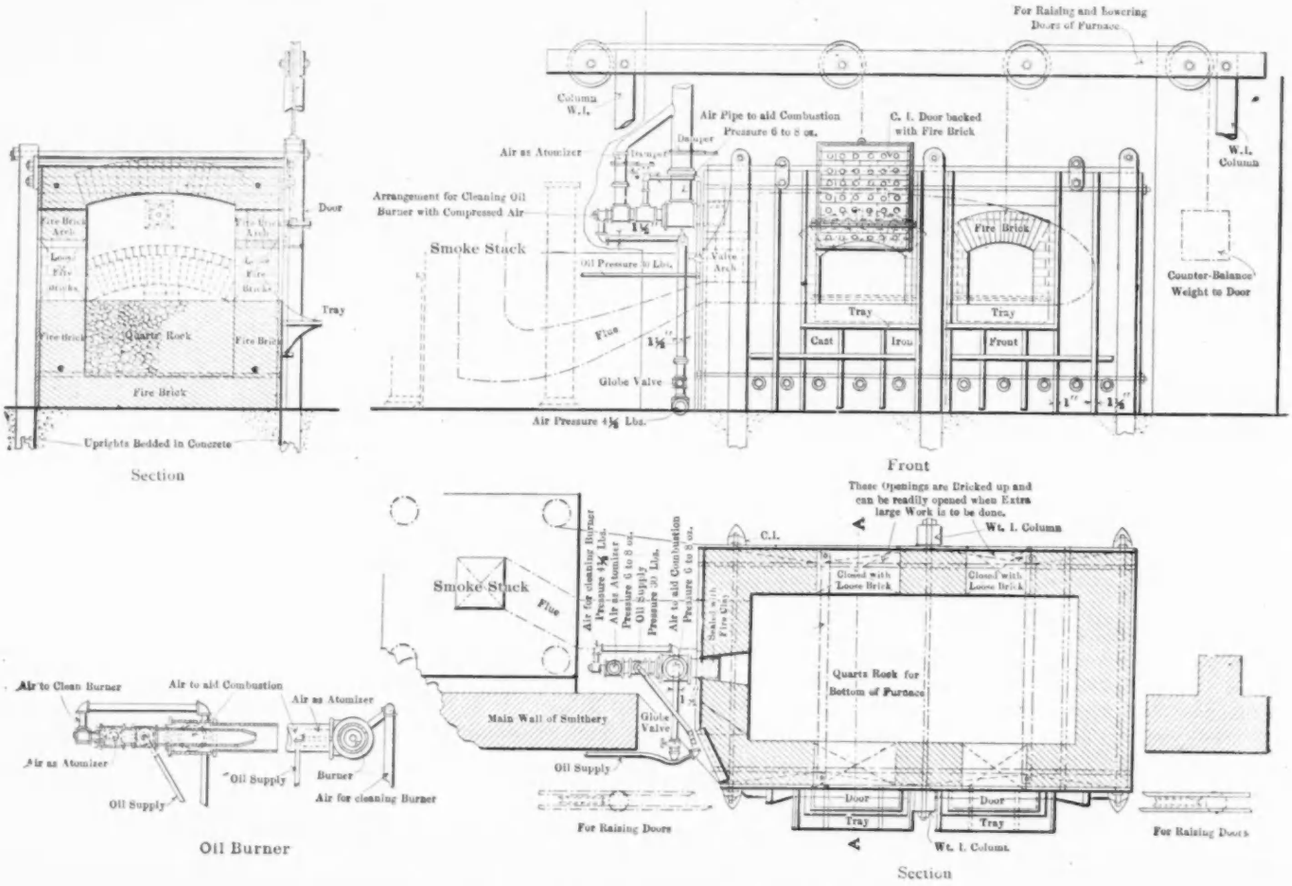


FIG. 10. OIL-FIRED REVERBERATORY FURNACE

blower to the other without shutting off the pressure. Fig. 9 shows the simple check valve used, which is satisfactory. Owing to the large increase in the demands made on the blowers by the increase in the number of fires and furnaces, both blowers are now running at nearly full capacity and there is no reserve in case of a break-down. This deficiency is to be remedied by the installation of another machine of the same type and size as those already in use.

For the reverberatory furnace, which requires a considerable quantity of air for combustion, it is more economical and also more satisfactory to use a combination of blast air at 6 to 8 ounces pressure for combustion and air at 4½ pounds pressure for atomizing. Fig. 10 shows the furnace and the combination burner and piping.

the cost of supplying the air for atomizing and the interest on the increased cost of the installation. With all of these considered, the operating costs with oil are considerably less than with coal on the Pacific coast. At other places this can only be determined by comparing the cost of oil and coal. The smaller cost of operation with oil is, however, far from being the only advantage of oil over coal. Go into any large smith shop and note the actual time of working heats compared with the time of waiting for heats, and the importance of reducing the waiting will be appreciated. With oil the heats are taken in very much less time than with coal, and this is the most important advantage. In a shop like the one under my supervision, where practically all work is done by day-work instead of piece-work, full benefit is not derived from this advantage as

Welding With an Oil Fire

There are some, not fully acquainted with the possibilities of oil, who will question the efficiency of welds made in an oil fire. The writer can assure such men that there are absolutely no grounds for their apprehension. When oil was first introduced this point was fully investigated. Two good smiths were selected, one to weld with oil and the other with coal, both in steel and iron. Samples were taken from the same bars and a large number of welds made and tested. The welds made with oil showed slightly better results than those made with coal, both as to tensile strength and elongation, but the advantage is small. In making a weld with oil, however, where the two parts are close together in the fire as is the case in welding a chain link, care must be taken that the parts to be welded are at a welding heat *throughout*. The heat is taken so quickly that a smith not accustomed to oil may obtain a welding heat on the surface only, and he will obtain a surface weld, which can only be discovered by breaking it. This may happen with an inexperienced man on other classes of welds but is more apt to happen where the parts are close together. Since the comparative tests were made, welds of all kinds have been tested at random, particularly those on which life depended, as hangings for ships' boats, and the results have been uniformly good.

Every class of work has been done in the oil fires, and no job has presented any difficulty. Ironwork for spars is rather difficult in any fire; for instance, a mast band with four or five eyes which have to be "jumped on." The advantage in this class of work is decidedly with the oil fire, as the heat can be localized and obtained exactly where wanted without heating the remainder of the work.

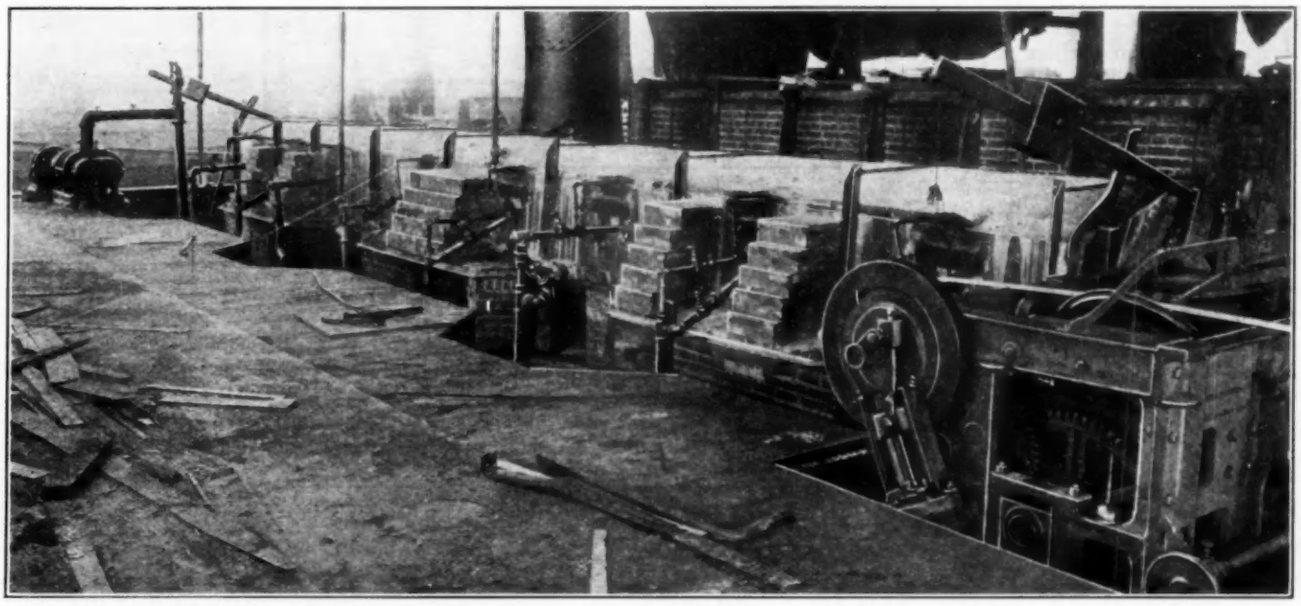


FIG. 11. ANGLE-HEATING FURNACE SHOWING ARRANGEMENT OF BURNERS

Advantages of Fuel Oil in Blacksmith Shop

The advantages of fuel oil are greater on the Pacific coast than in other parts of the United States, as the cost of coal is high and oil is cheap. Good blacksmiths' coal on the Pacific coast costs from $14 to $18 a ton, while crude oil can be had for 65 cents to 85 cents per barrel.

The consumption of oil depends entirely on the size of the forge and the class of work. It also depends on the care exercised by the operator in shutting off the supply while working his heat. A few good oil meters shifted around the shop from one operator to another will prove to be a good investment. Even a very careless man will soon learn to shut off his oil when he knows that the meter is telling the story of his carelessness to the boss.

In comparing the cost of operation of coal and oil, the cost of the fire brick used with oil fires must be considered, also

the operator has no incentive to reduce the time of his heats, and the longer he takes with his heat the less the work he has to do. Even under these conditions the advantage of oil over coal is marked. Another advantage is that with oil there is always a clean fire, which is conducive to good work, particularly in welding. Still another advantage is the better conditions under which the men work. With oil, a fire once started should not smoke. If it does smoke it shows inattention on the part of the smith in not regulating the combination of oil and air. Too much oil is being fed. With oil a clean shop can be maintained, the workmen are free from the smoke and fumes common to all coal-burning shops and working under better conditions the men can and should produce more and better work.

Figs. 11 and 12 show two views of an angle heating furnace and the general cleanliness of the surroundings can be seen.

Comparative Costs

In a medium-size forge with a medium fire on general work, the consumption of coal is 250 pounds in 8 hours. On the same class of work the consumption of oil is 25 gallons in 8 hours. On the Pacific coast the cost of coal fuel for such a fire is about $2 against a cost of 50 cents for the oil fuel. For the past eight months the fire brick used by each smith has been charged against him, and the record shows for such a fire a consumption of from 175 to 220 bricks for eight months, starting with a forge already built. Taking the maximum, the cost for fire brick is not more than 5 cents a day per forge. With coal fuel the cost of hauling the coal from the bins and removing the ashes is not inconsiderable; it is believed that the cost of the power for driving the 4½-pound pressure blowers and the maintenance of these would not equal the cost of handling the coal and ashes. With oil fuel electric current is generated at less than 1½ cents per kilowatt hour, so that the cost of power for the two 40-horse-power blowers running at full capacity does not exceed $8.50 per day.

The comparison of the cost of operation shows a great saving in favor of oil fuel. The greatest economy of oil, however, is in the increased output. With oil the fire can be lighted in the morning and a working heat obtained in one-third the time necessary with coal. The heats are taken in very much less time than with coal; with 2½ years' experience with oil I have no hesitancy in stating that the output with oil is from 40 to 50 per cent. greater than with coal. A very good proof of this statement is found in a remark made by one of the smiths. I was discussing with the foreman the advantages of oil fuel; he called one of the smiths and asked him which he would rather use, oil or coal. The smith without any hesitation stated that he preferred coal. When asked for his reason, he stated with astonishing frankness, "We take the heats with oil too quick and have to work too hard; the oil makes old men of us sooner than coal."

The economy of oil in the furnace is equally as great as in the open fires. The consumption of oil is 250 gallons per day against 1½ tons of coal as formerly used, that is, $25 for coal fuel against $5 for oil fuel. The output with oil has proved to be one-third more.

Oil Fuel for Galvanizing Pots

The use of oil fuel for the galvanizing pot presents some difficulties. It is essential that a uniform comparatively low temperature should be maintained. This temperature varies, of course, with the class of work, small work requiring a higher temperature than large work. If a uniform temperature is not maintained, not only will the work be unsatisfactory, but the loss from drossing will be large. The loss of zinc by dross in a well regulated pot under good conditions is, as every galvanizer knows, a serious drain, and if the conditions are not good the excessive dross can easily wipe out the profits. The pot itself must be protected from the intense heat near the burner; the installation of an oil burner which plays directly on the sides of the pot will surely result in burning it out. After considerable experience and a number of experiments, satisfactory oil-fired galvanizing tanks have been developed and have been in use for 18 months. Figs. 13 and 14 show a large and a small galvanizing pot as successfully installed. These tanks were built for coke, were changed to oil, and the present arrangements were developed from time to time from experience gained. Under these conditions the tanks are not in some unimportant details as would now be laid out for a new installation. They are nevertheless interesting, as they present installations actually in use giving satisfactory service. Fig. 15 shows a 13-foot-6-inch tank which will probably be installed in the near future.

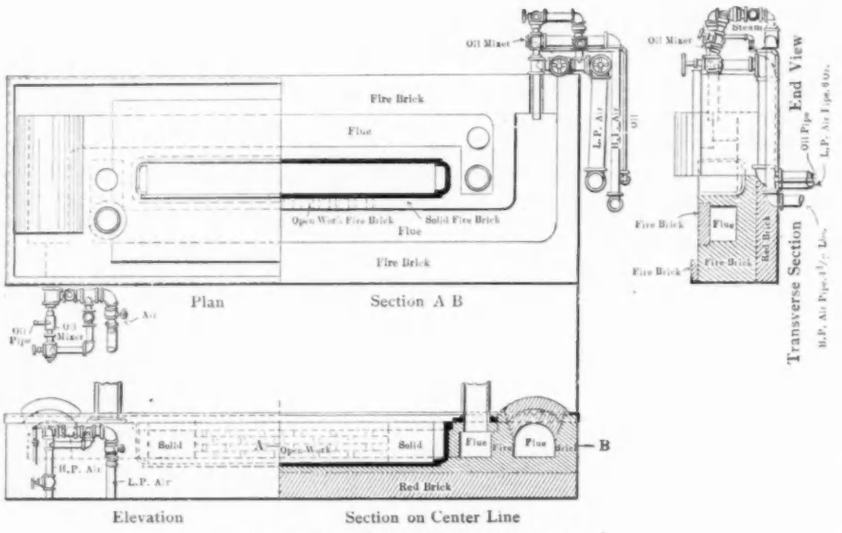


FIG. 13. GALVANIZING TANK OIL FIRED

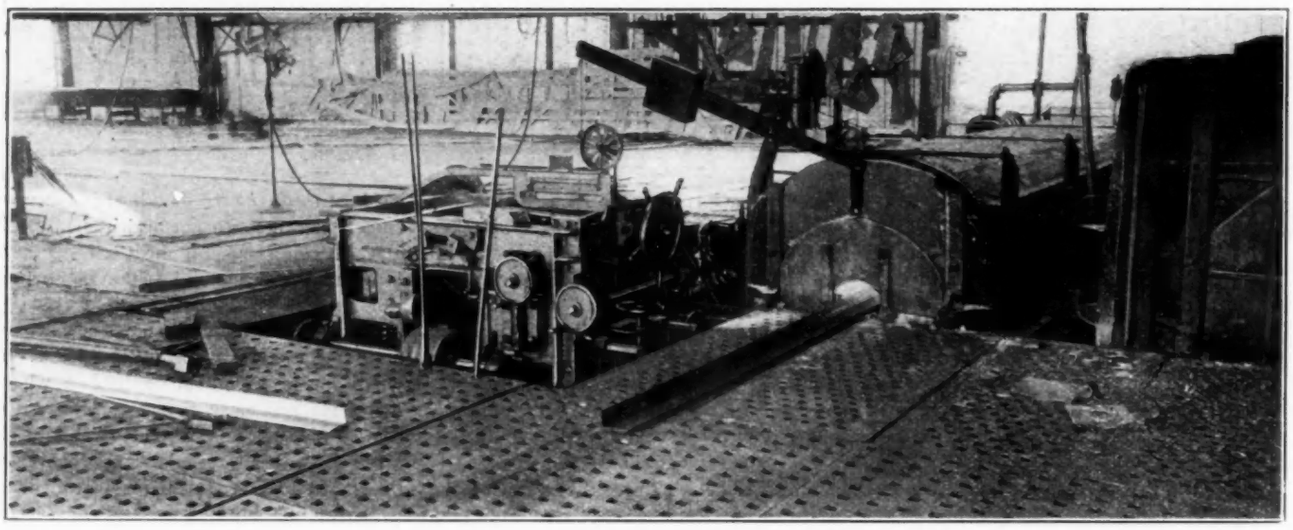


FIG. 12. FRONT OF ANGLE-HEATING FURNACE

While the illustrations show the details, it is desirable to call attention to the necessity of providing away from the pot a furnace or combustion chamber from which a flue is led to communicate the heat to the pot. In no other way can a uniform temperature be obtained and danger of burning be avoided. It will be noted that the ends of the pots which are riveted are protected by solid brickwork. This is necessary on account of the change of direction of the flue at these points, which would cause excessive heat on the corners.

The open spaces between the fire brick which protect the sides of the pot gradually increase from the end near the furnace to a maximum of 3 inches at midlength, and then are gradually reduced until the solid brick at the far end is reached. This was found necessary from experience gained with the first installation. When the first installation was made, it was realized that the rear end would be hotter than the middle portion; but it was not thought that the end near the stack would be hotter than the middle, and the loose fire brick along the side of the pot were arranged to have the minimum opening at the end nearest the furnace and the maximum opening at the end near the stack. With the pot in operation it was found that the zinc in the end near the stack melted first, and a pyrometer showed that this end was getting too much heat. The loose brick were rearranged as shown and a uniform heat is now obtained. The stack referred to consists of a short length of pipe about 4 feet high. With the pot in operation and the burners properly regulated, there should be no smoke. In starting the fire, however, with a cold pot there will be some smoke for the first few minutes until the combustion chamber is warmed. The average consumption of oil in the large pot, Fig. 13, is 9 gallons per hour, while the average consumption in the small pot, Fig. 14, is nearly 5.5 gallons per hour.

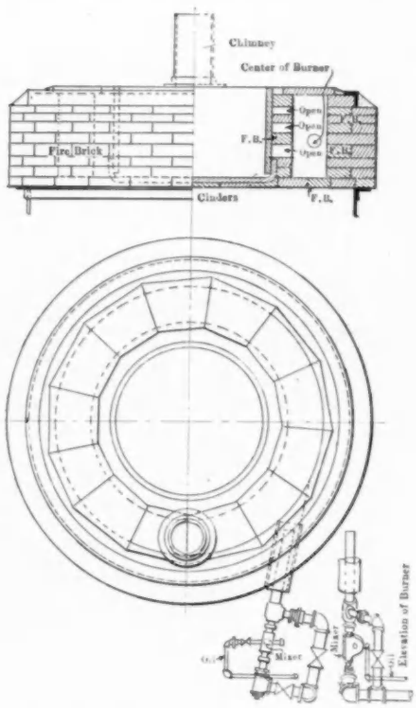


FIG. 14. SMALL GALVANIZING POT

Fuel Oil in a Core Oven

The core oven is fitted for both oil and coke. This is desirable as power is not available at night and it is frequently necessary to keep a heat on the core oven over night. The oven is heated during the day by oil and when a heat is required at night a slow coke fire is built in the furnace shortly before quitting time. The oil burner as first arranged gave some trouble on account of smoke and the difficulty of regulating it. This was due to the fact that the burner was originally installed in the coke furnace and the space into which it discharged was so large that it required some time to get this space heated; until this was accomplished, there was smoke. The burner discharges into a comparatively small combustion chamber which is quickly heated. This chamber is fitted with a small flue. When the burner is first lighted, the damper from the oven proper is closed and the damper in the combustion-chamber flue is opened, so that the smoke caused by lighting the burner goes out of the latter and does not enter the oven. When the combustion chamber is heated, the damper in the combustion-chamber flue is closed and the oven damper is opened.

Fuel Oil in Brass Furnaces

The brass furnaces are of the ordinary well known revolving type and present no points of interest other than that 15 to 20 gravity oil is used. When the furnaces were installed some years ago, 28 to 32 gravity oil was used. As this oil cost about four times as much as 15 to 20 gravity oil, about three years ago I slightly enlarged the openings in the burners so that the heavier oil would flow through them and have ever since used the cheaper oil with excellent results. The oil supply is taken from the circulating system described in connection with the blacksmith shop.

Fuel Oil for Melting Pig Iron

A description of the furnace used for melting pig iron in the foundry and fired with oil cannot be given at the present time, owing to applications that are being made for patents. It will suffice at present to state that pig iron is melted in this manner, that the cast iron produced is superior to that produced in a cupola and the fuel cost is much lower. Test bars show from 24,000 to 26,000 pounds tensile strength and are very uniform. It is expected that a full description can be given of the furnace and the process in the near future.

The use of oil for annealing armor, coppersmith forges, portable furnaces and plate and angle furnaces presents no special features and needs no description.

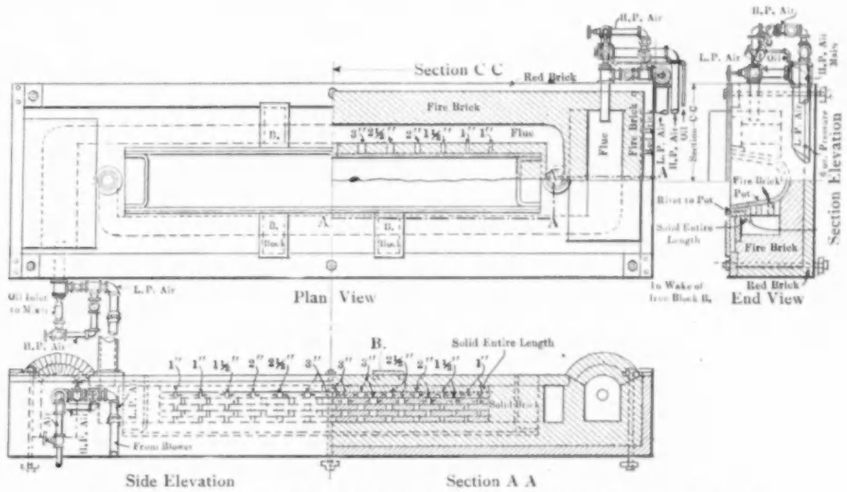


FIG. 15. AN OIL-FIRED GALVANIZING TANK 13 FEET 6 INCHES LONG

Of the estimated total of 200 million dollars worth of merchandise exported from the United States during 1907 machinery of various forms approximates 95 million dollars. The exact figures for the eleven months for which statistics are available show 87½ million dollars worth of machinery which is made up as follows: Metal working machinery, nearly 10 millions; electrical machinery, nearly 9 millions; sewing machines, about 8 millions; locomotives, 8½ millions; typewriters, over 6 millions; mining machinery, nearly 6 millions; stationary engines and boilers, over 5 millions; wood-working machinery, 1¼ millions; pumps and pumping machinery, 3½ millions; cash registers, 2⅓ millions; printing presses, 1⅔ millions; shoe machinery, over 1 million; and laundry machinery, over a half million dollars.

A Magnetic Absorption Dynamometer

Power is Transformed into Heat in an Armature Revolving in a Magnetic Field and the Heat Is Absorbed by Water

BY C. M. GARLAND

The dynamometer described in this article is the result of an attempt to meet the demand of testing laboratories and engine builders for a satisfactory means of absorbing the power given out by engines and motors under test. At the present time the devices used for this purpose are numerous and vary from a 2x4 scantling with one end under the fly-wheel and a workman on the other, to a dynamo placed in a cradle and producing current to be absorbed by lamp banks or water rheostats. Between these extremes fall the well known Prony brake, the Alden brake, the fan blower and the water wheel, all of which have been used to some extent for the absorption of power and all of which labor under more or less serious disadvantages.

The difficulties attending the use of those types of brakes which depend upon mechanical friction for the absorption of power are well known. There is always a tendency in the brake to bind or "seize," due to a change of temperature, to a change of the water supply, or to a change in the pressure between the friction surfaces from an increase in the load. This tendency of the brake to "seize" renders the regulation of the load for smooth running exceedingly difficult, and, in the case of high speeds, such as are found in steam-turbine practice, renders the use of this type of brake even dangerous, as any "seizing" at these speeds may result in the failure of a coupling or the tearing loose of the rotating mass from the supporting shaft.

The fan blower and water wheel have not, I believe, been used to a very great extent for the absorption of power. While they do not labor under the disadvantages named above, there are other objections to their use which are just as serious, such as the difficulties in varying the load or the speed and the large size required for large powers.

Probably the nearest approach to an ideal absorption dynamometer is to be found in the dynamo supported in a cradle. The generated power is absorbed in the production of electric currents so that there is no danger of seizing. The load is easily regulated by the turning of a rheostat arm. The principal objection, however, is the difficulty of absorbing the current. This is particularly true for the absorption of large currents. Practically the only available means are lamp banks and water rheostats, both of which are cumbersome, occupy valuable space and require considerable attention.

From this brief consideration of absorption dynamometers it is seen that there is room for improvement in this particular line. I will now describe the type of dynamometer which I designed and which is in use in the mechanical engineering laboratory of the University of Illinois. It depends for its operation upon the fact that eddy currents are induced in a conductor revolving in a magnetic field of varying density. The reaction between the eddy currents and the field that produces them develops a torque similar to that produced between the rotor and stator of an induction motor. Later these eddy currents short circuit themselves in the armature and produce heat which is carried off by the cooling water. In construction it consists simply of a soft-steel disk securely keyed to a shaft and revolving between two large field magnets. The construction of the magnets is such as to produce a field of varying magnetic density. The armature and pole pieces are inclosed in a water-tight casing, and means are provided for the circulation of water around them. Fig. 1 shows a side elevation of the dynamometer mounted in temporary bearings. Fig. 2 shows the dynamometer belted to a 60 horse-power engine. Fig. 3 shows the armature and casing. It will be noted that the armature is provided with radial grooves for the circulating water. This water enters through the field castings on each side of the armature near the center, and is thrown out through the radial grooves and the air gap between the armature and the pole faces. It is then led to waste by a connection through the bottom of the casing. This casing is shown to the left of the armature in Fig. 3.

Fig. 4 shows the assembled fields, the weighing arm and the end-thrust collars. The fields are made up of three pieces, the field casting, containing an annular recess for the field coil; bearings for the driving shaft and two intermeshing radial pole pieces which are held together and made water-tight by having lead cast in the interstices around the radial poles. The pole pieces are bolted to the field casting and completely inclosed the field coil. While the armature is practically balanced between the two fields, brass bearing rings are provided to prevent the armature from rubbing the pole faces, and to take care of any unbalanced end-thrust that may be caused by a slight difference in the air gaps on either side of the armature.

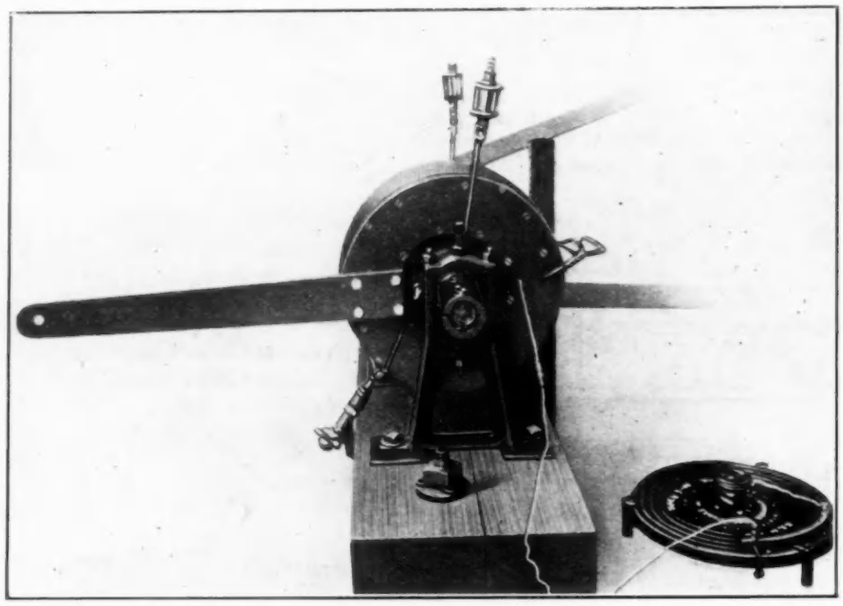


FIG. 1. THE GARLAND MAGNETIC ABSORPTION DYNAMOMETER

This machine is 17 inches in diameter, occupies 9 inches on the shaft and at a speed of 1800 revolutions per minute absorbs 34 horse-power. From recent tests it has been found that the power absorbed is very nearly proportional to the speed. The field coils are connected in series and the load is varied from 2 to 34 horse-power by simply turning the arm of the rheostat. The load remains practically constant; there is no tendency to seize and very little tendency for the load to

fluctuate with changes in quantity or temperature of the cooling water. The machine is noiseless in operation and entirely free from the splashing of water and oil. In the half-tones accompanying this article the dynamometer is shown equipped with a weighing arm. In order to measure the power, the force at the end of this arm must be weighed. This particular arrangement, however, is not necessary. A spring balance may be connected directly to the casing or field casting and to the bed plate or supporting frame, or the machine may be calibrated for given amounts of exciting current, and, instead of weighing the load simply measure with an ammeter the current flowing through the field. Then, from curves showing the relation between exciting currents, speed and horse-power, the power absorbed may be obtained without calculation. There is one disadvantage in this machine, that is, for slow speeds it is hardly practicable to build the dynamometer sufficiently large to absorb the power given out when direct connected. Thus belting or gearing must be resorted to. For speeds above 1000 revolutions per minute it is entirely practicable to build the machine so that it may be direct connected to the engine or motor to be tested.

Thanks are due to Prof. L. P. Breckenridge and Assistant Prof. J. C. Thorpe for assistance given in the development of this dynamometer.

The prosperous conditions of English cotton and woolen mills, in which 8,000,000 new spindles and 77,000 new looms were added during 1907, is commonly mentioned in connection with the electric drive.

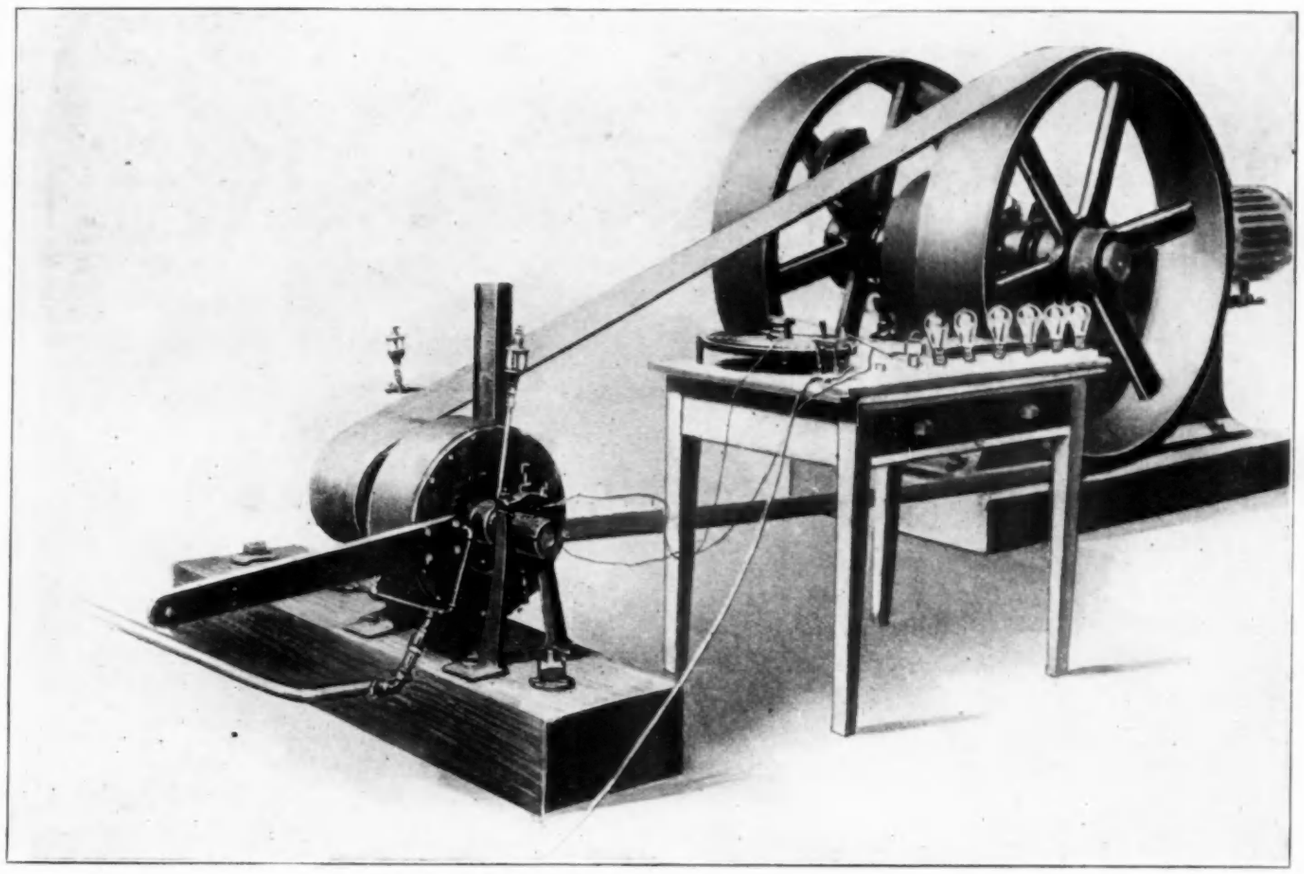


FIG. 2. THE DYNAMOMETER BELTED FROM AN ENGINE

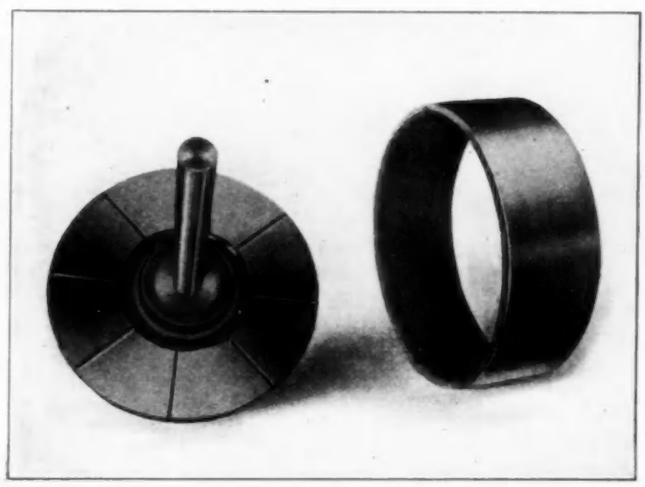


FIG. 3. DYNAMOMETER ARMATURE AND CASING

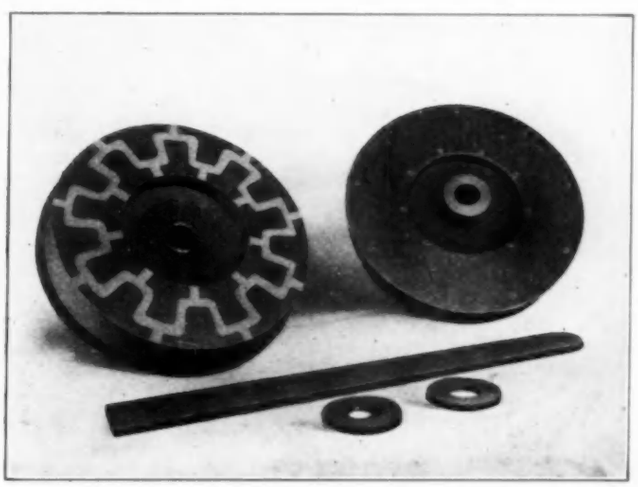


FIG. 4. DYNAMOMETER MAGNETS AND SOME OF THE SMALLER PARTS

A Multiple-spindle Automatic Turret Lathe

The Gridley Automatic with Four Spindles and Non-Rotating Tool Slide for Simultaneous Operations on Four Bars of Stock

SPECIAL CORRESPONDENCE

In the accompanying engravings we illustrate the Gridley multiple-spindle automatic turret lathe built by the Windsor Machine Company, Windsor, Vt. The single-spindle automatic built by this concern our readers are already acquainted with, it having been illustrated in these columns at page 1624, Vol. 27, and page 571, Vol. 30, Part 1.

The four-spindle machine forming the subject of the present article is well illustrated by the general views Figs. 1, 2 and 3; its construction will be understood by referring to these half-tones and to the details presented in the line drawings. Like the single-spindle machine referred to, the new automatic has a four-sided slide for carrying the "turret" tools; the tool slide in this case, however, is not rotated to bring the tools one after another into position for the successive cuts, as the four spindles themselves are carried in a cylinder that is indexed step by step to bring each spindle necessarily into position for the bars of stock to be operated upon by the various tools.

All of the "turret" tools held by the rotating tool slide are fed forward together, one tool rough turning the bar in one spindle, another tool taking a finishing chip on the piece held in the next spindle, a die threading the piece in the next spindle and the finished piece being cut off and a new length of stock fed through the chuck at the fourth position of the spindle, or such other operations being performed as the piece may require. As all of these operations are performed simultaneously, it will be seen that the time to make a completely finished piece and cut it off will be only the time required to perform the longest operation plus the time required to return the tool slide, revolve the spindle cylinder and move the tools back to their cutting position.

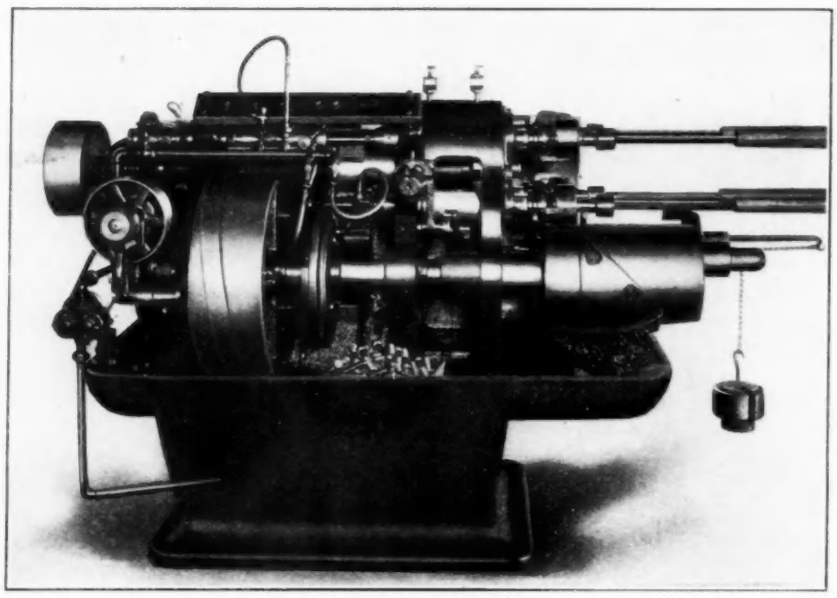


FIG. 2. REAR VIEW OF MULTIPLE-SPINDLE AUTOMATIC TURRET LATHE

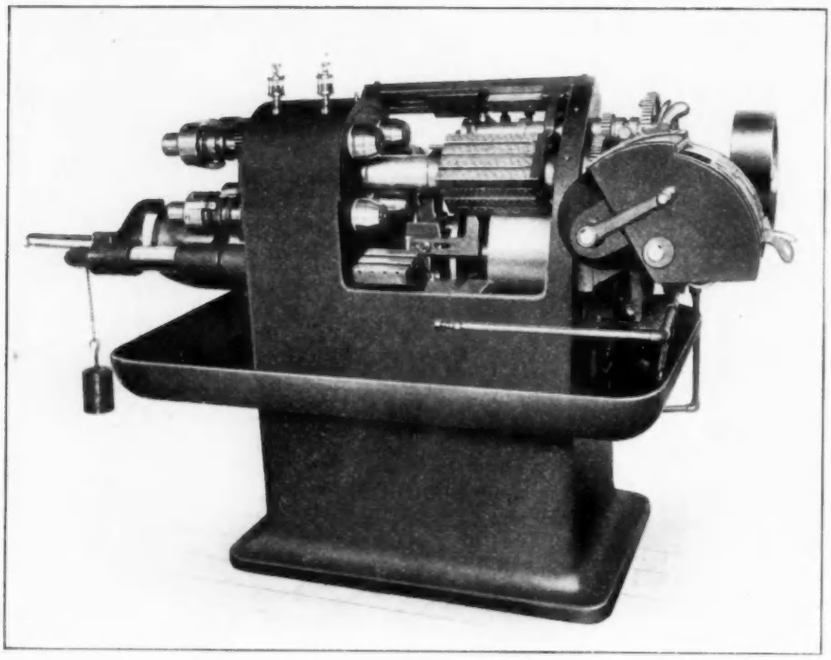


FIG. 1. MULTIPLE-SPINDLE AUTOMATIC TURRET LATHE

The Spindle and Tool Slide

The spindles, their carrying cylinder, and the tool slide are shown in Fig. 3 removed bodily from the machine; this half-tone reveals also a number of other interesting features of construction. A horizontal section through one of the spindles is given in Fig. 4, and it will be noticed that the spindle takes a long, straight bearing in a lumen-bronze sleeve which admits of ready renewal as a whole in the event of sufficient wear occurring to make this necessary. The hub of the cylinder around which the four spindles are located is extended, as represented in Fig. 1, to form a long bearing for the tool slide, this feature of mounting spindles and tool slide on the same member having been adopted in conjunction with the feature of large bearing areas to insure permanent alinement of spindles and tools. The bearings of the spindle-carrying cylinder are on the large diameters *A* and *B*, Fig. 3. In the event of any wear taking place between these surfaces at either end and the bearings formed in the main frame of the machine, the alinement of spindles and tool slide need not be affected, as both will simply move together.

In addition to the features just described, Figs. 1 and 3 show clearly the method of preventing the tool slide from rotating, the arrangement consisting of an arm attached to the tool slide and machined at the outer end to fit a longitudinal guide bar located as represented at the top of the machine.

The spindles have the usual collets and stock-feed device, and are driven by the pulley shown at the right-hand end of the machine in Fig. 1. This pulley is keyed to one end of a driving shaft running through the center of the spindle-carrying cylinder as in Fig. 4 and carrying on its other end a gear meshing with a gear keyed on each of the spindles at the rear end of the bearing. The spindles are run constantly in one direction without stopping or reversing for the purpose of threading, that operation being taken care of by the threading mechanism to be referred to later.

Operation of the Tool Slide

The cam shaft *C*, Figs. 3 and 5, carries the cams for operating the tool slide and the forming and cutting-off tools; the cams for operating the chuck and feeding the stock; and the mechanism for revolving the cylinder. It is driven at two speeds, one of which is comparatively slow for use during the time the tools are cutting, the other, a high speed, for returning the tool slide and revolving the spindle cylinder. During the slow movement (while the tools are cutting) it is driven by a worm *D*, Fig. 5, on the spindle-driving shaft, through the change-gear box *E*, worm shaft *F* and worm gear *G* keyed on cam shaft *C*. When the tools have finished cutting, the loose pulley *H*, which runs at a constant speed, is clutched to the worm shaft *F*. The drawing shows a toothed clutch for this connection, but a friction is now used instead. This method of cam-shaft driving gives a quick change feed for the cutting tools and a constant maximum speed for what are termed "idle movements," irrespective of the rate of speed during the cutting period. The quick-change gears in the feed box *E* are controlled by two handles, the lower one *I* having three locations corresponding to the feed cam used, there being three of these cams furnished, one for work not over 2 inches long, one for work between 2 and 4 inches and the other for work ranging between 4 and 6 inches in length. Although the 6-inch cam can be used for the shortest work, there is of course an appreciable loss of time in moving the tool slide its full travel when working short pieces. When the lower handle is in the position corresponding to the feed cam which is being used, the upper handle *J* can be placed in any one of the six positions to give the feed desired, the figures 75, 100, 125, 150, 175 and 200 representing the revolutions of the spindle to one inch of travel of the tool slide.

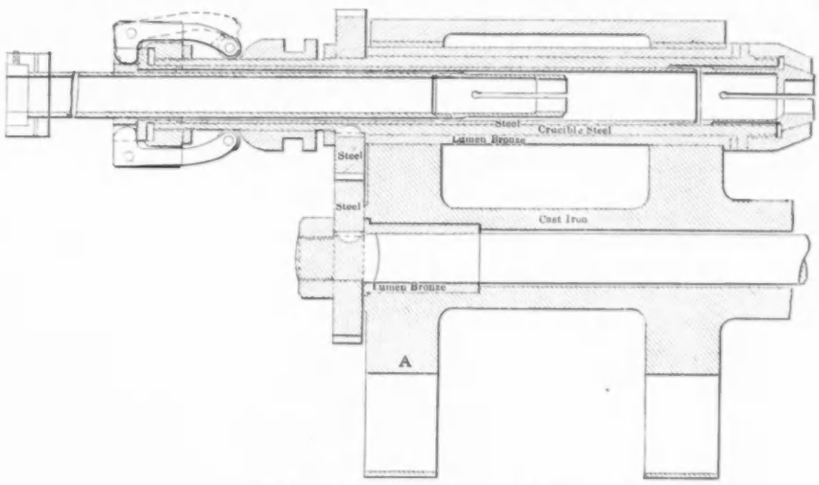


FIG. 4. SPINDLE CONSTRUCTION

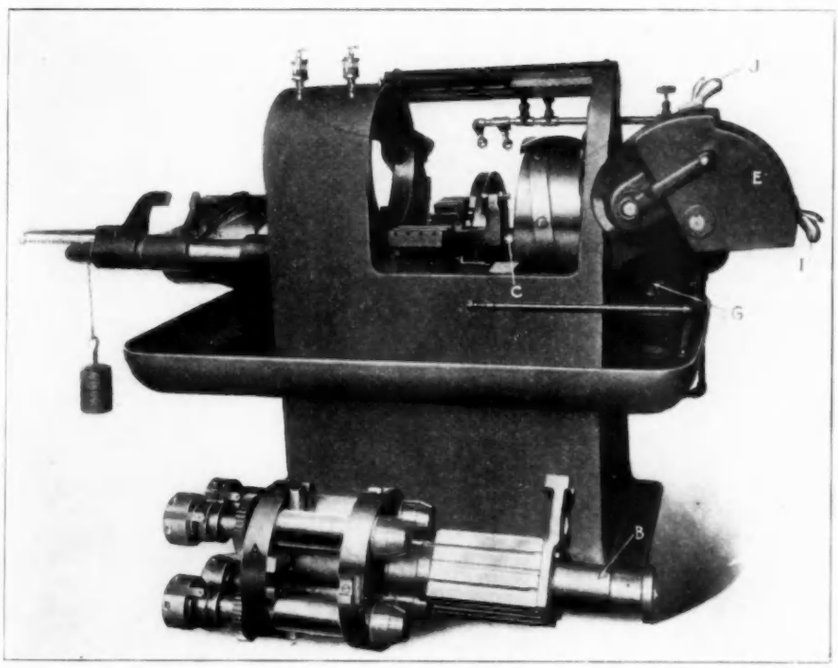


FIG. 3. TURRET LATHE WITH SPINDLES AND TOOL SLIDES REMOVED

Turning and Threading Apparatus

The form of tool slide allows a turning tool to be used identical with those employed on the Gridley single-spindle automatic turret lathe. One of these turners is shown in Fig. 6. The tool slide has sufficient room to allow of one tool being placed back of another.

As the spindles are driven constantly in one direction, as stated above, and in order that a high cutting speed for the turning tools and a low cutting speed for the die can be used, it is necessary to rotate the die at a speed slightly less then the speed of the spindle while threading, and at a higher speed when running the die off the piece. This is accomplished by means of two gears on the spindle-driving shaft, these gears meshing with two loose gears on the threading shaft, which in Figs. 1 and 2 is shown immediately above and to the rear of the tool slide. These gears are of such ratio that when one of them is clutched to the die shaft it will rotate the die at a speed slightly less than that of the spindle; when the other gear is clutched to the shaft, the die will rotate at a higher speed so as to run the die off. When a left-hand thread is being cut, the die rotates faster than the spindle during the threading operation and slower when running off.

The Indexing Mechanism

The mechanism for revolving the spindle cylinder is illustrated by Fig. 7, which also shows the method of operating the locking bolt. Arm *K* mounted on the cam shaft carries a cam *L* for withdrawing the locking bolt *M* and has at

its inner end a roll which at each revolution of the arm enters the channel in the face of the cylinder flange and rotates the cylinder one quarter turn, the locking bolt then dropping back into the next notch. The various sections show the cylinder just before the rotary movement commences and just after it has taken place, the locking bolt being shown in place in one view and withdrawn in another. Further explanation of the mechanism is unnecessary as the drawings illustrate the scheme fully. It may be stated, however, that the index notches for the lock bolt are formed in tool-steel shoes, secured in rectangular pockets in the periphery of the cylinder.

The machine illustrated has a capacity for 1⅛-inch round stock, 1-inch hexagon and ¾-inch square stock. Its weight is about 4500 pounds.

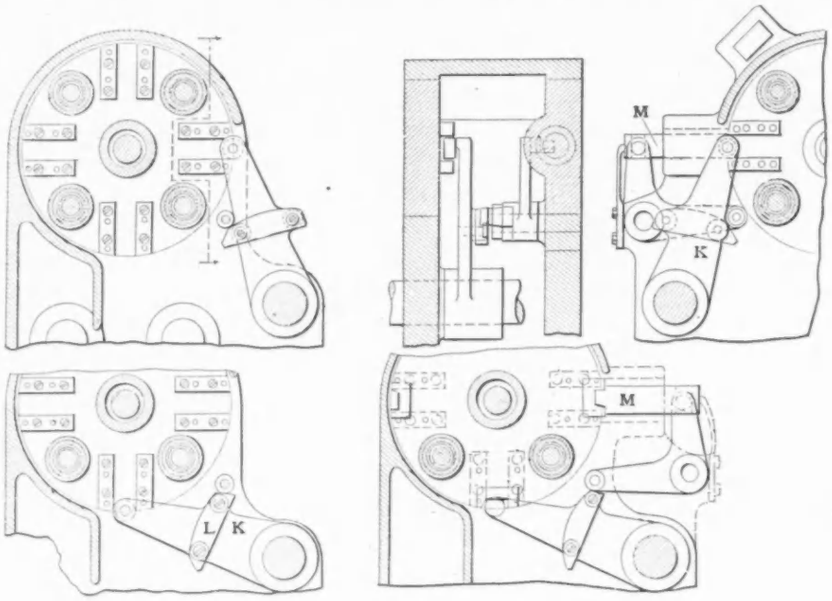


FIG. 7. CYLINDER-REVOLVING AND LOCKING MECHANISM

Labor Conditions in Canada

By B. Barcroft

While business is slack in the United States, the trade will no doubt be interested in learning where there are still openings.

Doubtless few who have not visited Canada realize the opportunities which this northern neighbor offers at the present time. While Canada has been somewhat affected by the same conditions that prevail in the United States, the slackness is not so great but is rather allowing a chance to catch up with the large quantities of overdue work, and at the present time there are jobs for first-class men. The skilled mechanic is scarce, for the growth has been too rapid to train enough for the vacancies, and the country is emerging from the jobbing-shop method of shop production to the duplicate, interchangeable standard of the times. This calls for toolmakers and all-around machinists, men who rate as first-class. For the average machinist or machine hand who specializes on one machine and can neither make tools nor take all-around work, there is no call; in fact, there are many of these out of employment at the present time, as this class of workmen is drawn largely from the Scotch and English emigrants who are coming into the country in numbers. Although as a rule they are not as handy or rapid workers as the Americans, to compensate for this they will work for a less rate.

This brings up the question of wages, and it must be admitted that the average Canadian manufacturer has not yet realized that good men require good money. This fact would account somewhat for the dearth of high-grade men. Although living is usually cheaper, varying considerably with the locality, wages will be about 25 cents a day less than are paid for the same grade of work in the United States.

Future prospects may also be of interest, especially to the young men who are looking for advancement, because the chances in this direction are unusually good. Because of the rapid increase in the number of concerns doing business and the enlargement of the existing ones, there are vacancies for men with executive ability as foremen, inspectors and superintendents. Also the man who is considering going in for himself has better chances than in the United States. While there are a few branches of the business which are fairly well organized to cover the country, the area is so great and the population so scattered that it makes it

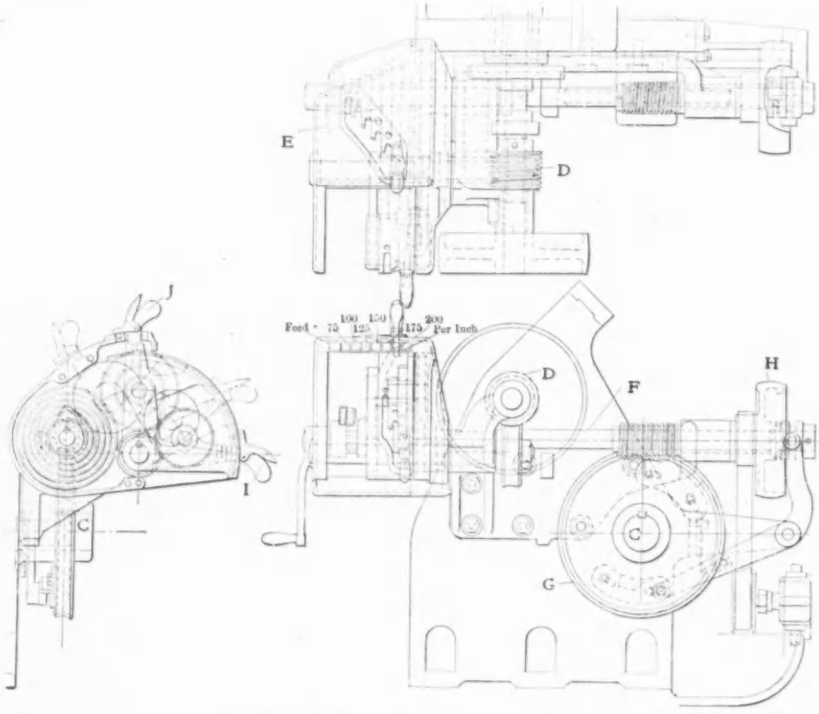


FIG. 5. THE FEED-DRIVING MECHANISM

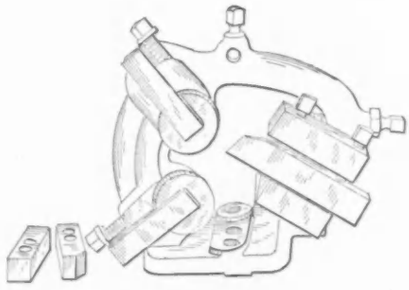


FIG. 6. TURNING TOOL

difficult and costly to control, with the result that competition cannot be as keen.

On the whole the outlook for the first-class man and for work is good and will continue so for some time.

[We would suggest that it is better to get information direct from the town you may think of going to before starting off on a journey that may cost considerable money.—ED.]

Machining Automobile Fly-Wheels

When automobiles are built in large quantities, as has been the case during the past few years, improved methods are naturally sought for machining the various parts; this has led to a considerable development in many lines of machine tools.

The accompanying illustrations show the machining of two types of automobile fly-wheels on the Gisholt lathe, as suggested by the manufacturers themselves. These operations include two types of fly-wheel, one of which can be finished at one setting, while the other requires two operations so as to completely finish both sides.

The first type of fly-wheel is shown in Fig. 1 in the three-jawed scroll chuck, in which the rim and hub are shown in sections. Wheels of this type are first chucked on the inside of the rim with special chuck jaws, as shown at *B*. These are steel jaws and grip the wheel firmly from the inside of the rim. The struts or chucking pieces *C* are bolted to the base of the chuck as shown, so that each fly-wheel may be put in the chuck in exactly the same way.

Those who are at all familiar with the Gisholt lathe will recognize the tools shown and that the front, top and back arms are wings for carrying facing cutters, as can be seen on close examination. The various tools are numbered in the order in which they are used on these fly-wheels, from which we see that the boring bar *M* goes through the cored hole of the fly-wheel into the bushing *R* in the chuck which supports it, while the cutter *N* bores the cored hole. Boring bar *M* 1, shown in No. 2, finishes this hole nearly to size and the floating reamer *Q* reams the bore of the fly-wheel exactly the size.

While the hole is being bored, tools *J* and *K* in the turret tool post are used for breaking the scale on the front base of the hub and of the rim. Tools *E* and *D*, held in the auxiliary or wing rest, break the scale on the back side of the rim. The tool *D* chamfers the inside of the rim, the chuck jaws being cut away slightly for this purpose, as can be seen at *B*.

After the hole is finished to size, tool No. 4 is swung into position, and while guided by the T, the cutters *F*, *G* and *H* do the rough facing of the rim and hub. Tool No. 5 is practically the same as No. 4 and is held in reserve for finishing the

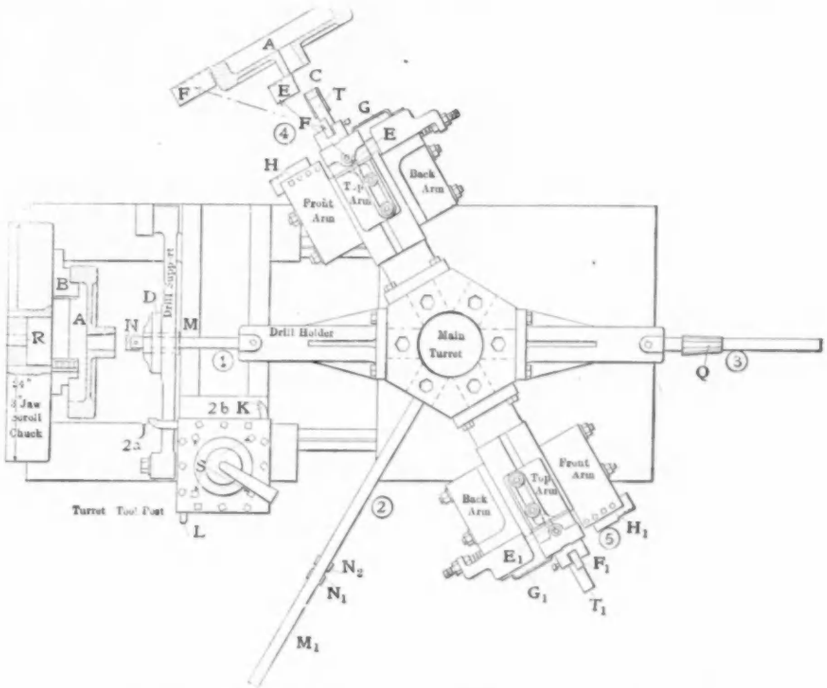


FIG. 2. FIRST OPERATION FOR A COMPLETELY FINISHED FLY-WHEEL

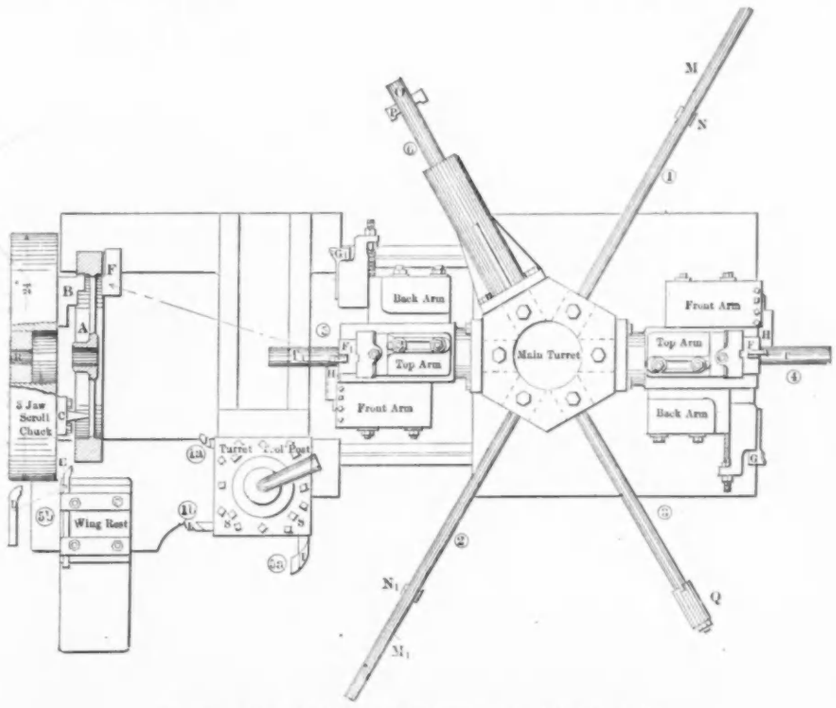


FIG. 1. FINISHING A FLY-WHEEL AT ONE OPERATION

hub and rim. The outside of the rim is finished by tool *L* in the turret tool post.

All that remains to be done is the finishing of the back side of the hub, which is accomplished by tool No. 6. The facing cutter *B* is removed while the bar *O* is pushed through the hole, when the cutter is again inserted and fastened in place. The turret is fed backward and the inside of the hub faced square with the bore.

A FLY-WHEEL THAT REQUIRES TWO OPERATIONS

The fly-wheel shown in Figs. 2 and 3 is of the webbed type and requires finishing on all surfaces. It is chucked in much the same way as the first wheel and the cored hole is rough bored with the cutter end *N* in the end of boring bar *M*, which is held in the drill holder and rigidly bolted to the face of the main turret. The bar *M* is guided by the drill support shown, so that any eccentricity of the cored hole may be very largely corrected during the rough boring. This drill support is then swung out of the way and the turret turned so that bar No. 2 or *M* 1

comes into position; the end of this is guided by the bushing *R* before the cutters *N* 1 and *N* 2 begin boring the hole to approximately the desired taper. This operation finishes the small end of the hole within 0.002 inch, so that very little is left for the reamer *Q*, which is also guided in bushing *R*.

While the hole is being bored and reamed, the tools *J* and *K* in the turret tool post are breaking the scale on the web and hub of the fly-wheel; before the boring and reaming are completed, the scale on the outside of the rim has also been broken up by tool *J*. Before using the rough-facing tools *F*, *G* and *H* No. 4 on the hub and web and rim of the wheel, a paper bushing *C* is slipped into the bore so as to form a guide for the arbor *T* while these operations are going on. This same bushing guides arbor *T* 1 for the finishing tools *M* 1, *G* 1 and *H* 1 at No. 5. This finishes one side of the fly-wheel.

For the second operation the fly-wheel is chucked by the soft jaws *B*, which have been bored to fit exactly the outside diameter; in addition, the work is supported by the bushing *C*, which also forms a guide for the supporting arbor in both the roughing and finishing facing tools.

Before either of these is put to work, however, the tool *K* in the turret tool bolt is used to break the scale on the inside of the face of the rim and also on the web. All that remains to be done is to use tools Nos. 1 and 2 so that the roughing cutters

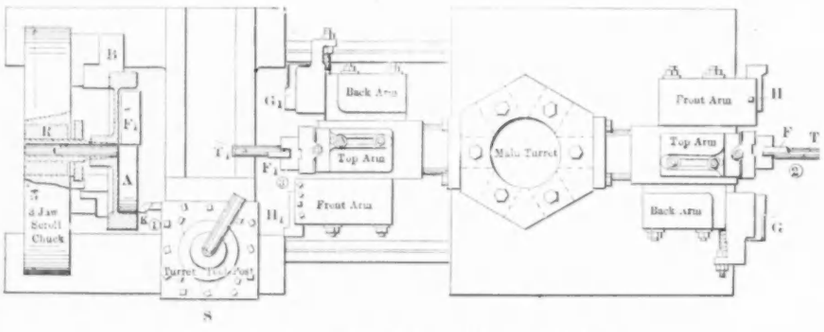


FIG. 3. FINISHING THE OTHER SIDE OF FLY-WHEEL

F, *G* and *H* and the finishing cutters *M* 1, *G* 1 and *H* 1 can finish the other side of the fly-wheel.

This and many other similar features in automobile construction can be handled very successfully on this type of machine, and the Gisholt Machine Company, Madison, Wis., has very carefully worked out a large number of these from practical observations. Its experience should be of great value to anyone interested in the manufacture of duplicate parts along this line.

The total cut of logs on the coast of British Columbia for the year ended June 30 was 339,343,662 feet, according to the books of the government supervisor of scaling.

A Press Die for Magnet-head Punchings for Inclosed Arc Lamp

By Julius F. A. Vogt

There is often objection to the use of follow dies where absolute accuracy of the product is required, but inaccuracy is mostly due to faulty construction and more to the lay-out of the die. I wish to describe a method of laying out multiple follow dies which is not so well known as it should be. I have designed and made a number of such dies where great accuracy was required and have found this method always perfect. The sketches show a sub-press die of the multiple-follow-die type for the production of magnet-head punchings for inclosed arc lamps.

The material for the punchings was high hard brass 1/16 inch thick. A correct templet with all the holes drilled and reamed was made of sheet steel about ⅛ inch thick, as shown in Fig. 2, because this templet was to be used as a drill jig for drilling the small round holes, as will be explained.

Fig. 1 shows the die, which is made of a piece of ¾-inch thick steel welded to a piece of 1-inch iron machined on top and bottom, and squared on the sides. At least it is necessary to have the two long sides of the die planed parallel. The two horizontal lines *A B* are marked first, allowing sufficient scrap between the blanks for the punches to cut on, which should never be less than the thickness of the material to be punched; for very light material more scrap is allowed. Next, the position of the vertical lines *C D E* for the upper row of blanks, and the dotted lines *F G H* for the lower row of blanks, is marked, allowing the same amount of scrap between the blanks from right to left as was allowed between the horizontal lines *A B*.

The centers of the upper row of blanks are at the intersection of the dotted lines *C D E* and the horizontal line *B*; the centers of the lower line of blanks are at the intersection of the dotted lines *F G H* and *A* of the die, as shown in Fig. 1.

The templet *I*, Fig. 2, is then placed with the center of the hole *M* on the intersection of the horizontal line *B* and the dotted line *C*, and marked with the scriber. This is repeated at the intersection of the horizontal line *A* and the dotted line *G*.

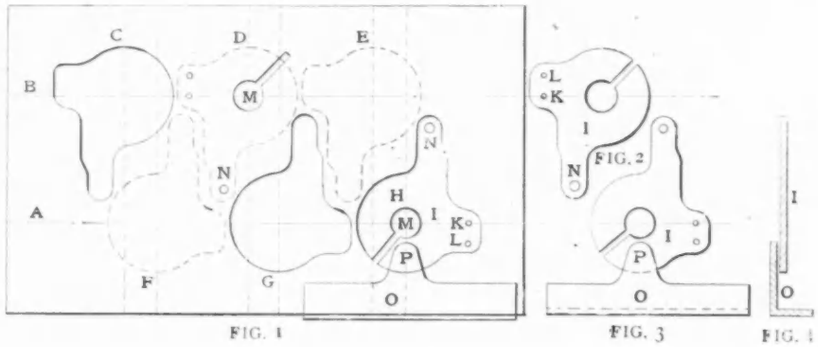


FIG. 1 FIG. 3 FIG. 4

LAYING OUT THE DIES

Having marked the blanking dies *C G*, we proceed to work them out and fit the templet *I* into these dies. We are now ready to transfer the piercing holes *L K M N* from the templet to the die. This is the most important work on the die. If the piercing holes are not marked on the die in exactly the same position as in the templet, the punching made with the die would not be accurate and no pilot pin on the cutting punches will make them right. To secure alinement of the piercing and blanking punches, the angle *O* with a projection as shown in Figs. 3 and 4 is made.

The templet *I* is put into the die *G*, the angle *O* is placed on the die *G* in Fig. 1, with the projection *P* overlapping the templet *I* in the die, care being taken that the angle *O* is close up against the side of the die. The angle *O* is then clamped to the die, and the projection *P* is soldered to the templet.

The angle with the templet is then removed from the die *G* and moved to the right, so that the center of the hole *M* in the templet is central with the line *H* on the die; the angle *O* is then clamped to the die, always being careful to have the angle rest close to the side of the die. The holes *N K L* are then drilled through the templet, using the templet as

a jig. Pins of proper size are now lightly driven through the templet into the die to prevent it from shifting while the hole *M* is drilled. The same operation is repeated at die *C D*. It will be seen that when the piercing holes in multiple dies are transferred in the manner explained by sketch Fig. 1 that it is impossible to get them out of line if care is taken. It does not matter in what position or at what angle the blank is located in the die, the transfer angle *O* will bring the piercing holes in the die in exactly the same position as the holes in the templet when sticking in the blanking die.

Of course the distance *C D E* and *F G H* must be kept alike. If, however, there should be a slight difference, it would not affect the accuracy of the punching; it would affect the scrap between the blanks only.

After all the holes are drilled in the die as shown in Fig. 5, the die is hardened and the face of the die is ground straight on the surface grinder. We are now ready to proceed with the punch.

Figs. 6 and 7 show an elevation of die and punch. The pad *N*, previously machined, is clamped on to the die, and the shank holes for the punches *M M* are drilled and secured in the pad; the holes for the punches *L L* and *K* are also located.

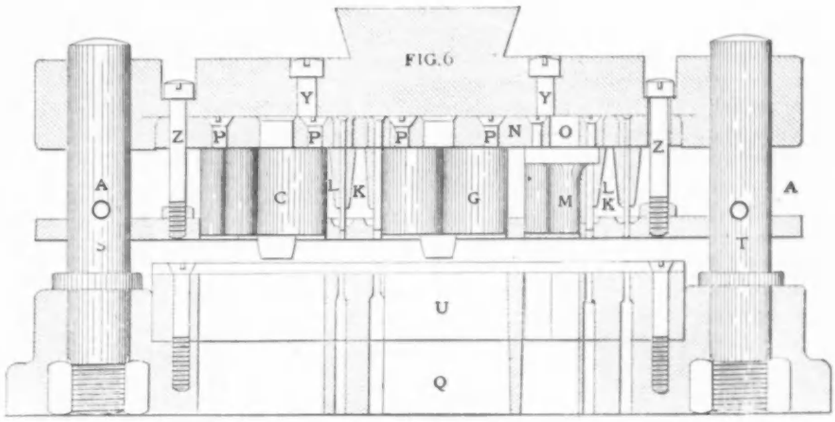


FIG. 7

SECTIONAL VIEW OF DIES

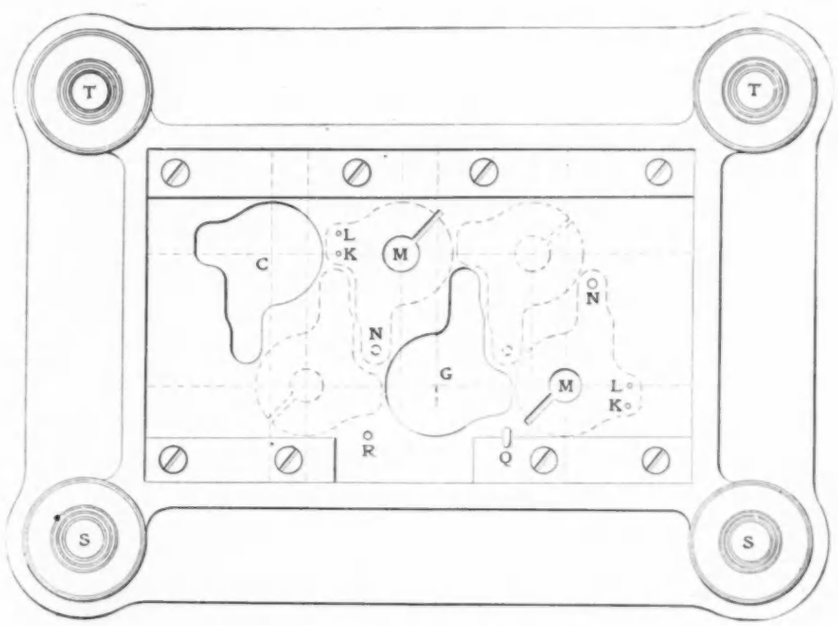


FIG. 5. A PLAN VIEW OF THE DIE

The pad is then removed from the die, and the screw holes *P P* and *O O* are drilled and countersunk. The punches *M M* are then turned to fit the hole in the pad, and the cutting part of the punches is turned to fit the die. The punches are then slotted in the milling machine, the flat part of the punches is fitted and fastened into the punch, and the punch fitted to the pad and fastened by means of the flat-head screws *O O*. The blanking punches *C G* are then machined and fitted to the die. The pilot-pin holes in the punches are marked from the templet *I* to the punch, and drilled through the punches. The punches *M M*, fastened to the pad, are then inserted into the die, and the screw holes for the punches *C G* are marked and drilled and tapped, then fastened to the pad and fitted to the die. The pilots are drilled through the punches into the pad and fitted as shown in Fig. 6. The piercing punches *L L* and *K K* are then made and inserted into the place.

The die bed *Q* and the punch plate *R*, previously planed on top and bottom, are then clamped together; posts *S S* and *T T* are drilled and reamed and counterbored for the hexagon nuts. The die *N* is then fitted to the bed plate *Q* and the posts *S S* and *T T* fastened to the bed plate. The stripper *X* is slipped on the posts, all the holes from the die are marked on the stripper and the holes in the stripper worked out to fit the punches. The punch plate *R* is then fitted to the punch; the screw holes *Y Y* for holding the pad to the punch plate, and the screws *Z* for holding the stripper to the punch, are drilled and tapped. The die is then put into a press for a test. If everything is all right the punch is taken apart and carefully hardened and then reassembled.

Operating the Die

The die is put into a press. Fig. 5 shows the oblong hole *Q* between the piercing die and the blanking die *G*. The material is held for the first cut close to the right-hand side of the hole *Q*. The punch, coming down, pierces the holes *N M* and *L K*. The material is then moved to the left, to pin *R*; the punch, coming down, cuts the blank *G*, pierces the holes *N M* and *L L* for the next blank and cuts the gage notch *Q*. Moving the material again to the left and putting the gage notch *Q* on to the gage pin *R*, the second blank *G* is cut and the holes *N M* and *L L* for the third blank are perforated, also the holes *M M L K* in the upper row of blanks. Moving the material again from *Q* to *R*, the fourth stroke of the press finishes two blanks and pierces the holes for the next blanks.

The method of cutting the gage notch *Q*, as shown in Fig. 5, is a very convenient one. It is the best way of gaging I know of; the notch is always before the eye of the operator, and if made as shown in the sketch, is always reliable, as long as the distance between *Q* and *R* is equal to the distance *C D E* and *F G H*, Fig. 1. The pin *R* should be about 1/32 smaller than the gage notch *Q*, to give the pilots a chance to draw the blanks in the proper position. To assist the pilots in their work the punches *C M N N N* and *L K* are 1/16 inch, or the thickness of the material to be cut, shorter than the punch *G*. Punch *G* cuts the blank loose, then punch *C* and the piercing punches do their work. In handling large pieces of material, as in this case, where the stock is 4⅝ inches wide by 8 or 10 feet long, the gaging must be as near foolproof as it can be made; and I think this is the case in the dies shown.

A Diagram for Designing Hoisting Hooks

Plotted from Professor Bach's Formula—How Hooks May be Properly Proportioned without Using Elaborate Mathematics or Tests

BY AXEL PEDERSEN

Hoisting hooks are the most commonly used form of curved beam and this discussion is based upon Professor Bach's theory and formula for curved beams, as given in his treatise on the strength of materials.

The stresses in eccentric loaded curved beams are generally calculated according to the straight-beam theory for combined bending and direct stress, and this method is still recommended in many text-books and technical papers. That the straight-beam theory does not apply to the actual conditions existing in curved beams has been shown by experiments and theoretical researches. In curved beams calculated according to this straight-beam theory, the tensile stress becomes considerably too low and the compression stress too high. In some cases the error exceeds 50 per cent. and the conscientious designer cannot afford to ignore this great discrepancy.

In calculating hoisting hooks it is most important that great care should be taken to use dimensions which will give a proper factor of safety, and crane-building companies have developed standard sizes based upon numerous experiments. In shops where new or special hooks are designed, and where no expensive tests are made, except those concerning the properties of the material used, a theory agreeing with mathematical research as well as experiments should have been accepted long ago.

In view of these facts I have plotted a diagram which is based upon the theory for eccentrically loaded curved beams. Of this theory I will only mention here, referring to Fig. 1 showing a hook of general design, that it is assumed that the radius of a curve, passing through the center of gravity of the different sections, at the important section M_1–M_2 is equal to the distance from the center of gravity of this section to the point of loading, or to the distance Z. This assumption is approximately true for hooks of usual design, and even where this is not exactly the case the error is very minute. In the diagram only the tensile stress occurring at M_2 is considered, as the compression stress at M_1 is comparatively very small.

Use of the Diagram

Referring to the diagram which is printed as an insert the known quantities are:

P = the load in pounds.

s = the maximum allowable tensile stress in pounds per square inch.

A = the distance from the point of application of the load to the nearest point of the important section M_1–M_2, or the radius of the inside of the hook.

An included angle of taper T from 25 to 35 degrees will suit most cases and

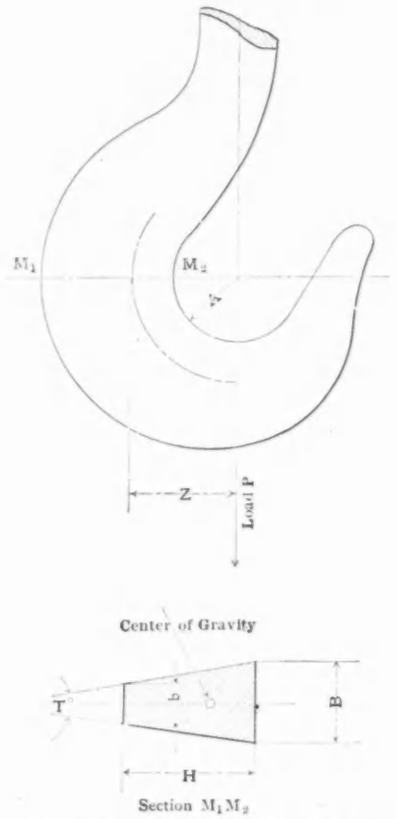


FIG. 1. GENERAL DESIGN OF A HOISTING HOOK

gives a well proportioned shape to the section.

We then calculate the ratio $\frac{P}{s} = Y$ and proceed as illustrated in the example.

An Example

Design a hook of 30 tons capacity, when the radius of the inside of the hook = 3 inches, maximum tensile stress = 15,000 pounds per square inch and the included angle of the taper = 25 degrees.

Here:

$P = 30 \times 2000 = 60{,}000$ pounds and

$s = 15{,}000$ pounds.

Hence

$$Y = \frac{P}{s} = \frac{60{,}000}{15{,}000} = 4.$$

$A = 3$ inches and $T = 25$ degrees.

Then locate $A = 3$ inches on "Dimension A-scale," trace a perpendicular to this A-scale downward until it reaches the line for 25 degrees among "Lines of included angle of taper for determining dimensions H and B." From this point trace parallel with the A-scale until line 4 of the "Lines of ratio Y" is reached. Now trace downward perpendicularly to the A-scale until the "curve" is intersected. Trace from this point on the curve parallel with the A-scale until line 3 inches of "Lines of dimension A for determining dimension H" is reached, then vertically upward and read the value of H on "Dimension H-scale."

Here $H = 9\frac{1}{4}$ inches.

From the point last reached on line 3 inches of "Lines of dimension A for determining dimension H" trace again parallel with the A-scale until line 25 degrees of "Lines of included angle of taper for determining dimension B" is reached; from here trace upward perpendicularly to the A-scale until line 3 inches of "Lines of dimension A for determining dimension B" is reached and read on the right vertical the value of B on "Dimension B-scale." In this case it is nearly $5\frac{1}{2}$ inches.

In order to find dimension b, start again at $A = 3$ inches on the "Dimension A-scale" and trace a perpendicular to the A-scale until line 25 degrees of "Lines of included angle of taper for determining dimension b" is reached and read the value of b on "Dimension b-scale" at the left of the diagram.

$b = 1 - 5/16$ inches.

The general procedure is shown by dotted lines on the diagram, and they will serve as a guide for solving other problems.

From the diagram we obtain a section with sharp corners, which of course should be rounded. The reduction in section due to this rounding and consequently the decrease of B to B_1, see Fig. 2, can be made up by increasing H to H_1 if such a refinement is desired.

The Fundamental Formula

For the benefit of those who may wish to understand the construction of the diagram I will give Professor Bach's formula and show its use in plotting the various lines of the diagram. Professor Bach's formula for the bending stress at any point of the section M_1–M_2, Fig. 3, of a curved beam is:

$$s = \frac{P}{f} + \frac{m}{fr} + \frac{m}{kfr} \times \frac{e}{r+e}. \quad (1)$$

in which,

Explanatory: The diagram determines the dimensions *B*, *H* and *b* in inches for the section *M N*, having given *A* the inside radius in inches, *P* the load in pounds, *S* the tensile strength of the material in pounds per square inch and the included angle of the section in degrees; *T* in the accompanying cut. The ratio *Y* is $P \div S$.

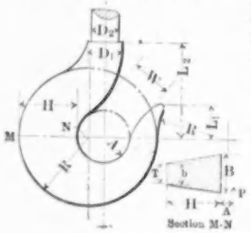
(*a*) ***To find the dimension H*** locate on the upper left-hand "dimension *A*-scale" the point corresponding to the dimension *A* selected. Drop a vertical from this point until it intersects the line corresponding with the angle selected of "lines of included angle of taper for determining dimensions *H* and *B*." From this intersection trace parallel with the *A*-scale toward the right to the line representing the calculated ratio *Y*. From this intersection trace a vertical line until it intersects the curve. Then trace a horizontal until it intersects the line representing the dimension *A* among "lines of dimension *A* for determining dimension *H*." From this point trace vertically upward until the dimension *H*-scale is reached. The value of *H* in inches may be read from the graduations.

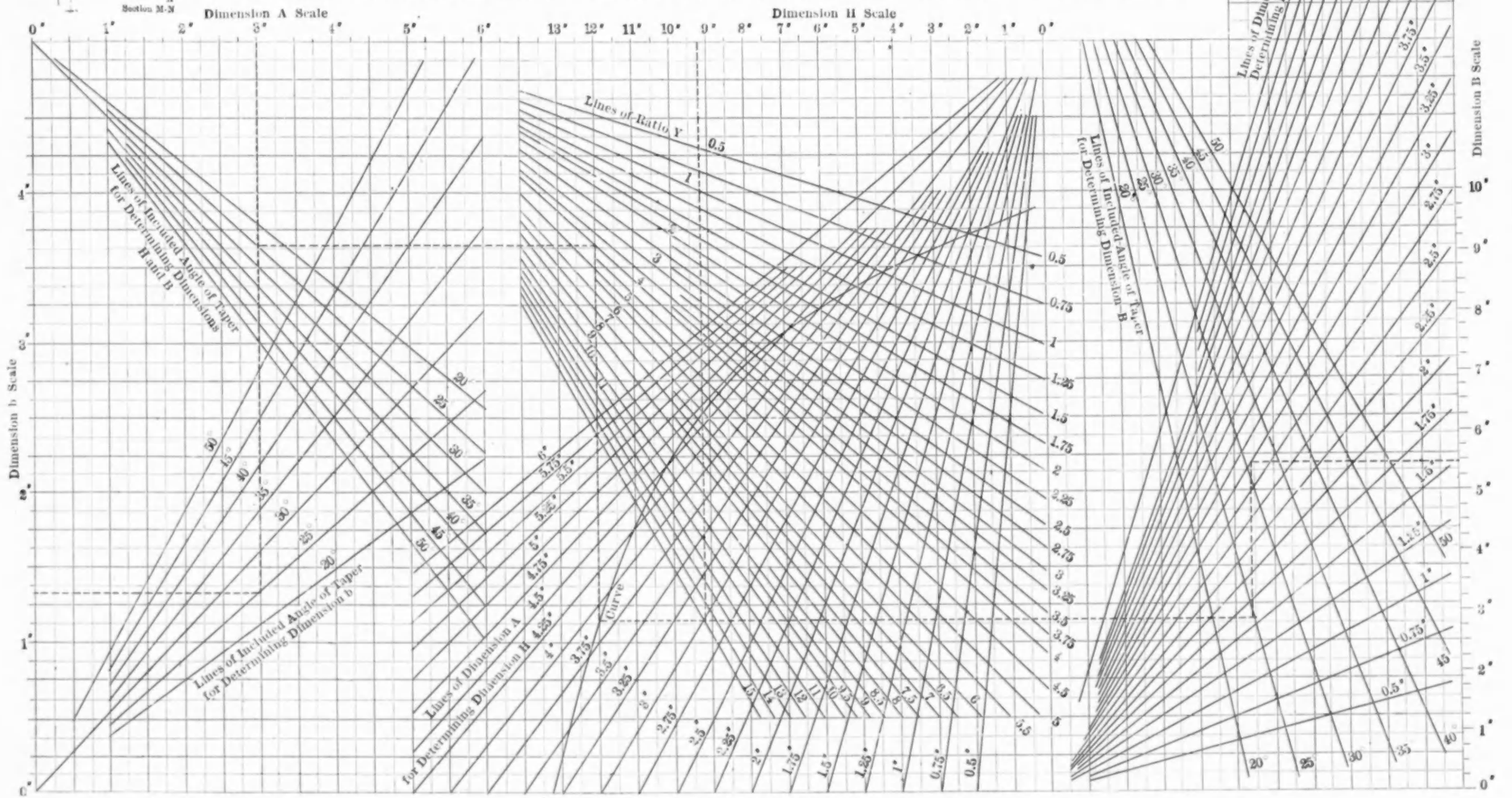
(*b*) ***To find the dimension B*** refer to (*a*) and return to the point of intersection on the curve. Trace to the right to the line indicating the angle among the "lines of included angle of taper for determining dimension *B*." Then trace vertically to the line representing the dimension *A* among "lines of dimension *A* for determining dimension *B*." From this intesection trace horizontally to the scale at the right-hand edge. The point reached represents the dimension *B*.

(*c*) ***To find the dimension b*** return to the upper left-hand "dimension A scale" and from the point representing the dimension *A* trace a vertical until it intersects the line representing the angle among "lines of included angle of taper for determining dimension *b*." From this intersection trace a horizontal toward the left to the "dimension *b*-scale." From this scale read the value of *b*.

(*d*) ***For determining the general dimensions*** of the hook the following relations may serve as a guide:

$D_1 = \sqrt[3]{P_1}$ where P_1 is the load in tons of 2000 pounds, $D_2 = \frac{7}{8} D_1$, $R = A + \frac{3}{4} H$, $W = 1.5\,A$, $L_1 = 1.3\,A$ to $1.6\,A$ and $L_2 = 3.3\,A$ to $3.5\,A$.




Dimension A Scale
Dimension H Scale
Dimension b Scale
Dimension B Scale
Lines of Ratio Y
Lines of Included Angle of Taper for Determining Dimensions H and B
Lines of Included Angle of Taper for Determining Dimension b
Lines of Dimension A for Determining Dimension H
Curve
Lines of Dimension A for Determining Dimension B
Lines of Included Angle of Taper for Determining Dimension B

PROPORTIONS OF HOISTING HOOKS

s = the stress due to bending.

P = the normal force producing stresses uniformly over the section; positive if the stresses are tensile (as in hooks), negative if the stresses are compressive.

m = the bending moment; negative if it tends to straighten out the beam (as in hooks), positive if it increases the curvature of the beam.

f = the area of the section.

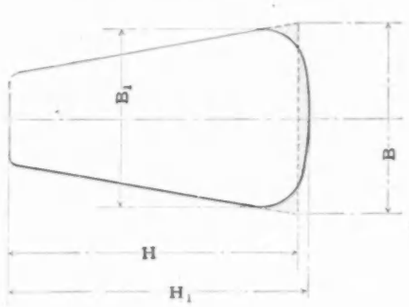


FIG. 2. CORRECTION OF DIMENSIONS OF SECTION FOR ROUNDED CORNERS

r = the radius of curvature for the center of gravity of the section; that is, for an axis passing through the center of gravity of the different sections of the beam.

e = the distance from the center of gravity to the infinitesimal fiber area df; negative if taken in the direction of the center of curvature, positive in the opposite direction.

k = a quantity obtained from the following formula:

$$k = -\frac{1}{f}\int \frac{e}{r+e} \times df. \qquad (2)$$

The integral must be taken over the entire section. For the trapezoidal section used in the diagram the value for k is:

$$k = -1 + \frac{2r}{(B+b)H}$$

$$\left\{\left[\frac{B-b}{H}(r+e_2)+b\right]\frac{23}{10}\cdot log.\frac{r+e_2}{r-e_1} - (B-b)\right\} \quad (3)$$

In which e_1 = the distance from the center of gravity to B and

e_2 = the distance from the center of gravity to b.

CONSTRUCTION OF THE DIAGRAMS

In designing the diagrams I assumed the distance from load line to the gravity axis to be equal to the radius of curvature at that point.

Hence

$$m = -Pr \text{ and } P = +P,$$

as the stresses are tensile.

Whence equation (1) becomes:

$$s = -\frac{P}{kf}\cdot\frac{e}{r+e}$$

Computing the maximum tensile stress, we have $e = -e$.

Whence

$$s = \frac{P}{kf} \times \frac{e_1}{r-e_1}, \text{ or,}$$

$$s = \frac{P}{kf} \times \frac{e_1}{A}.$$

Multiplying this equation by B and solving for AB, we find:

$$AB = \frac{P}{s} \times \frac{e_1 B}{kf} \qquad (4)$$

As k is only a function of the dimensions of the section and the radius of the curvature, the expression $\frac{e_1 B}{kf}$ is a constant for a particular section and radius of curvature.

Putting

$$\frac{e_1 B}{kf} = \lambda, \qquad (5)$$

and $\frac{P}{s} = Y$ (this ratio being used in the diagram) formula (4) becomes:

$$AB = Y\lambda. \qquad (6)$$

We assumed

$$r = A + e_1,$$

and putting

$$\frac{B}{b} = x + 1. \qquad (7)$$

and

$$e_1 = \frac{H}{3}\cdot\frac{B+2b}{B+b}, \text{ or}$$

$$e_1 = \frac{H}{3}\cdot\frac{x+3}{x+2},$$

we obtain from equation (5) combined with the special value of k given in equation (3) the following:

$$\lambda = \frac{(x+1)(x+3)}{\left[x+3+\frac{3(x+2)}{x}\right]\left[(x+2)\cdot\frac{23}{10}\,log.(x+1) - x\right] - \frac{3}{2}\cdot(x+2)} \quad (8)$$

Equation (8) gives λ as a function of the ratio x only. This greatly facilitates the design of the diagram.

Using equation (7) and introducting the included angle of taper T in the calculation, we easily arrive at the following:

$$b = 2A\,tan.\left(\frac{T}{2}\right), \qquad (9)$$

$$B = 2A(x+1)\,tan.\left(\frac{T}{2}\right) \qquad (10)$$

Putting this value for B in formula (6) and solving for A, we find:

$$A = \sqrt{\frac{Y}{2\,tan.\left(\frac{T}{2}\right)}\cdot\frac{\lambda}{x+1}} \qquad (11)$$

For a particular value of Y_1 and T_1 the dimension A_1 is a function of x only, as λ is a function of x only; thus:

$$A_1 = \sqrt{\frac{Y_1}{2\,tan.\left(\frac{T_1}{2}\right)}\cdot\frac{\lambda}{x+1}}. \qquad (12)$$

And selecting

$$T_1 = 30°,\ 2\,tan.\left(\frac{T_1}{2}\right) = 0.536$$

and $Y_1 = 0.536 \times 9$,

we have

$$A_1 = 3\sqrt{\frac{\lambda}{x+1}}.$$

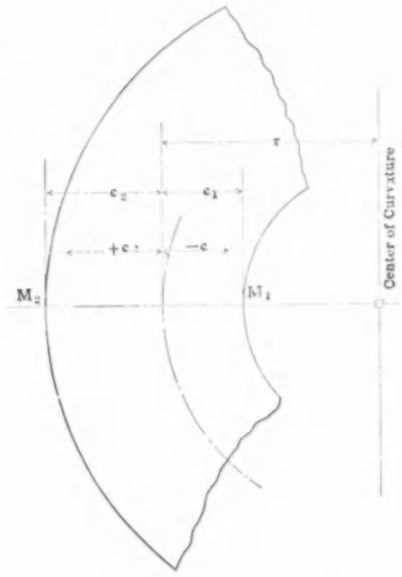


FIG. 3. PORTION OF A CURVED BEAM

The curve in the diagram was plotted according to this relation by inserting the values 1, 1¼, 1½, etc., for x and using equation (8) for λ. The diagram is shown in outline in Fig. 4. A convenient scale was selected for the ratio x on the IV—V axis having its zero point at IV. The scale for the dimension A_1 being on the V—VII axis with its zero point at VII, is the first A-scale.

As

$$x = \frac{H}{A},\ H = x\,A.$$

The curves representing the relation between H and x will become straight lines for a particular value of A. Substituting 0.75, 1, 1.25 inch, etc., for A and selecting the IV—VI axis as the H-scale with its zero point at IV, the IV—V axis being the x-scale with its zero point at IV, straight lines being named according to the A-value can be drawn from point IV. Only one of them is shown in Fig. 4.

For another value of Y_2 or for $Y = Y_2$, we will have, keeping T_1 and x constant:

$$A_3 = \sqrt{\frac{Y_2}{2\ tan.\left(\frac{T_3}{2}\right)}\ \frac{\lambda}{x+1}}. \quad (13)$$

which combined with (12) gives:

$$\frac{A_2}{A_1} = \sqrt{\frac{Y_2}{Y_1}}, \text{ or for } Y_1 = 0.536 \times 9.$$

$$A_2 = \frac{455}{1000}\ A_1 \sqrt{Y_2}.$$

The values 0.5, 0.75, 1, 1.25, etc., are then substituted for Y_2 and the resulting straight lines (Ratio Y lines) between A_2 and A_1 drawn from VI, a convenient scale for A_2 being selected on the axis VI—VII with its zero point at VI and is the second A-scale.

If now the included angle of taper varies, the ratio Y and x being kept constant, we will have:

$$A_3 = \sqrt{\frac{Y_2}{2\ tan.\ \frac{T_3}{2}}\ \frac{\lambda}{x+1}},$$

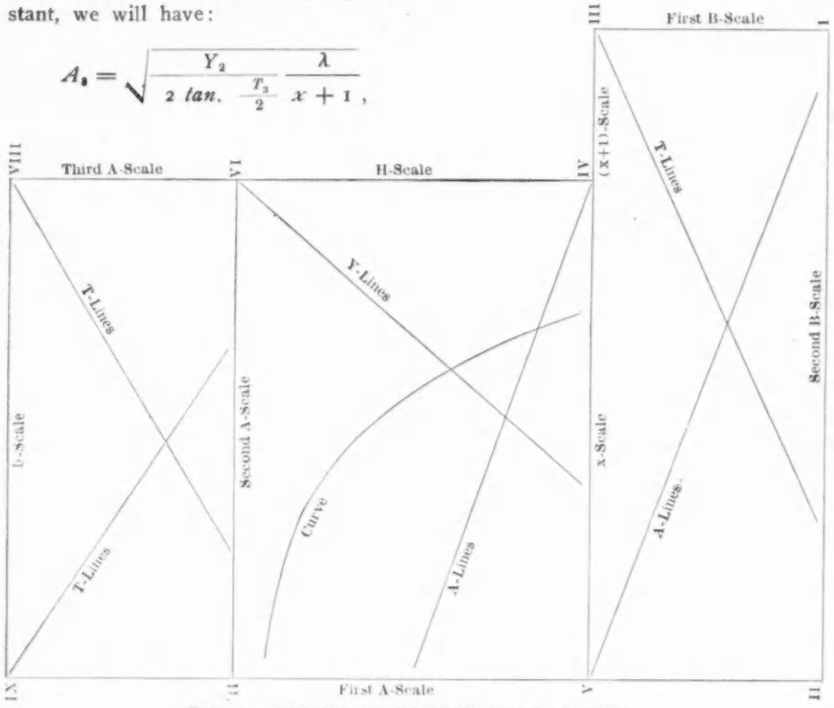


FIG. 4. OUTLINE OF HOISTING-HOOK DIAGRAM

which with equation (13) gives:

$$\frac{A_3}{A_2} = \sqrt{\frac{tan\left(\frac{T_1}{2}\right)}{tan.\left(\frac{T_3}{2}\right)}},$$

or for $tan.\left(\frac{T_1}{2}\right) = tan.$ 15 degrees.

$$A_3 = \frac{517}{1000} \cdot A_2 \sqrt{cotan.\left[\frac{T_3}{2}\right]}.$$

Inserting $T_3 = 20$, 25, 30 degrees, etc., straight lines can be drawn from VIII as resulting lines between A_3 and A_2. The axis VIII—VI is the A_3-scale with its zero point at VIII and is the third A-scale. This is the resulting A-scale for the diagram.

For determining the dimension b graphically, using equation (9), we have:

$$b = 2\ A_3\ tan.\left(\frac{T}{2}\right).$$

Select the axis $VIII$—IX as b-scale with its zero point at IX. Substitute the values 20, 25, 30, degrees, etc., for T and draw the resulting straight lines between b and A_3 from point IX.

The dimension B is arrived at by using equation (10), which for a particular value for A, say $A_1 = 1$ inch, becomes:

$$B_1 = A_1\ (x+1)\ tan.\left(\frac{T}{2}\right) = (x+1)\ tan.\left(\frac{T}{2}\right). \quad (14)$$

Here we must select III as the zero point for the scale B_1, point III being one unit (in terms of x) from the point IV. The axis III—V represents the $(x+1)$-scale with its zero point at III also.

By substituting $T = 20$, 25, 30 degrees, etc., we can draw straight lines from the point III as resulting lines between B_1 and $(x+1)$ according to equation (14). The axis III—I is the B_1-scale or the first B-scale.

If $A = A_2$ we will have

$$B_2 = A_2\ (x+1)\ tan.\left(\frac{T}{2}\right),$$

which combined with (14), x and T being kept constant, becomes:

$$\frac{B_2}{B_1} = \frac{A_2}{A_1}, \text{ or}$$

$$B_2 = A_2 B_1 \text{ for } A_1 = 1 \text{ inch}$$

Having the axis II—I as the B_2-scale or second B-scale with its zero point at II, draw from the point V the resulting straight lines between B_1 and B_2 according to the equation $B_2 = A_2 B_1$ by substituting the values 1, 1.25 inch, etc., for A_2. The lines are named corresponding to the A_2 values. The B_2-scale is the resulting scale for the dimension B in the diagram.

The Sand-blast Machine, "an Electrical Generator"

By B. O'Reilly

A curious phenomenon which I have not seen in any publication came under my notice recently. We have had a sand-blasting apparatus in operation for some time, in the form of two cylinders made of sheet steel. These cylinders are arranged vertically, the larger one being uppermost. The lower one forms both a column to support the whole machine and a chamber to contain fine, sharp sand. The two chambers are connected with one another by a length of rubber hose of about 1½ inches internal diameter. At the end of the hose which is inside the upper chamber, there is a nozzle of cast iron, the bore being about ¼ inch diameter.

The machine is worked by compressed air, of an average pressure of 5 pounds per square inch. The compressed air forces up the fine sand from the lower chamber, through the rubber hose and nozzle into the upper one. When operating the machine, the hands are inserted through two openings in the upper chamber. One hand holds the tool which is to be cleaned, while the other, holding the nozzle, directs the current of air and sand in the required direction. The operator is enabled to observe the progress of the work through a small window which is on a level with his eyes.

A man who was using the machine complained that he had received, or imagined he had received, a curious kind of blow or shock to his arms—nothing serious, but sufficient to make him note the fact. A day or two after, a pipe fitter who had some alterations to make, laid his hand on the rubber hose. He received a shock which startled him. I then tried to get results by the "laying on of hands," but failed. Another man, however, who was near, grasped the hose, when he at once received an undoubted shock. I distinctly saw the spark and heard the sharp crack which accompanies a discharge of static electricity. As a further proof that the hose was electrified, I took a long thread from a piece of cotton waste; this was attracted by the hose, as were also other light substances.

A water-gage glass tube was slipped upon a round steel rod so that about 12 inches of the steel rod stood out at each end of the gage glass. Holding the gage glass in the left hand, the steel bar was fairly well insulated, while one end was sand blasted; so long as the jet continued to play upon this end, sparks could be drawn from the other. The use of dry hot sand gave the best results.

According to the report of the Geological Survey, the value of the mineral products of this country in 1906 was $1,902,506,206, against $1,623,928,720 in 1905.

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

The Inverted-V versus the Flat-bed Lathe—The English and the American Way

The editorials at page 532, where you take up the question of inverted V's for lathes, and where the American boy and his British cousin are commented upon, interested me, as I agree with you in the one case and disagree with you in the other.

Professor Nicolson, whose opinion you comment upon, is evidently not a lathe builder; as I am not, neither of us can be charged with being biased by commercial notions, and the question is one bearing on the advantages and disadvantages of the two systems. He starts out with the assumption that the inverted V has no advantages except the one which can be reversed by saying that one of the advantages of the flat way is that it is far more convenient to sit down on. Another advantage is that all the chips, grit and dirt which fall upon it will stay there until forced off by the slide. It has the advantage, too, of liberal wearing surfaces; so far as wearing directly down, that must take place very slowly. But wearing down, whether fast or slow, has very little bearing on the question of doing good work.

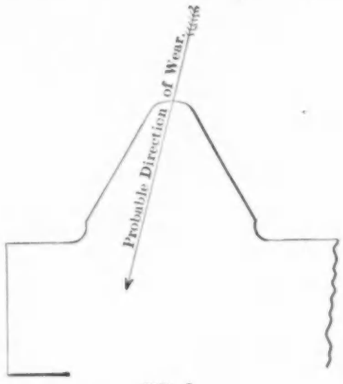


FIG. 1

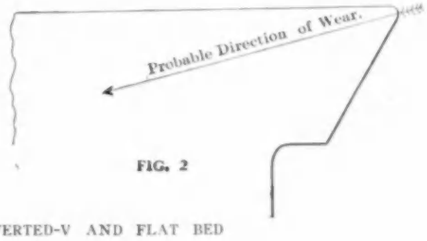


FIG. 2

COMPARISON OF INVERTED-V AND FLAT BED

The top of the flat ways might easily be (to exaggerate) 1/16 inch crooked and make no perceptible difference in the truth of a cylinder, whereas 1/16-inch curve in the back edge of the flat way would make the cylinder ⅛-inch larger at one point than at another. The guiding surface at the back edge of a flat-way lathe is not usually more generous than our inverted V's are. When this edge is beveled under to an angle of 60 degrees, the top and edge form a V of practically the same character as our V's, and the pressure comes in relatively the same direction referred to the point of the V; see Figs. 1 and 2, which he ridicules. Very few American lathes have V's of so acute an angle as the one shown, and some of the flat-way lathes have square edges at the back, which are better.

The guiding of a carriage at the back edge of the bed, where the work and driving power are at the front, is only less ridiculous than would be the using of a T-square with the guiding head at the right hand of the drawing board and moving it with the left hand, as the width of the lathe bed is narrower than the drawing board and the slide rest is longer than the head of the T-square.

The effect of wear in the case of the flat way is worse than that of the inverted V in this; when the back way wears the most at one part of the bed, the slide is free to shake and skew around to a certain extent; if the wear is more at one place than elsewhere, as is always the case, and the slack is taken up, it becomes too tight at other places. The carriage guided by the inverted V never has slack motion and can never skew, whatever may be its other defects. Another thing, the wear that takes place from using the flat-way lathe for boring is added to the effect of wear in turning, so far as slack of the slide and skewing of the carriage are concerned; whereas in the case of the inverted V, the wear of the V in boring is deducted from the wear in turning. The two combined drop the slide; but the lowering of the slide at different points has very little effect on the truth of the work compared to wear in the horizontal direction.

About the excessive wear of the inverted V as compared to the flat way, that is true so far as American practice in small lathes goes; but that is entirely unnecessary, as there is no earthly reason why the V's cannot be made to have a generous wearing surface. In the lathe, illustrated in the AMERICAN MACHINIST in 1889, in which the front V is about three times the width of the V used in the usual American practice for lathes of its size (16-inch or 8-inch English) and the slide rest 36 inches long instead of 16 inches or 18 inches, the 25 years of constant use show no appreciable wear. This result may not all be due to generous surface, for with the long slide the wearing surfaces are infinitely better protected.

I expect that if Professor Nicolson takes any notice of this, his reply will be that when the ways of a lathe wear so there is shake in the slide it is time it was refitted; but everything that wears so as to require refitting never gets fixed until it is too bad to use.

From the great changes that have been made in the American lathes in the last two or three years, it is evident that our builders have become convinced that there were a lot of things wrong; I believe that there are others that need to be corrected, but I do not believe that Professor Nicholson has hit upon that which will be greatly improved by adopting the flat way.

About the other editorial subject, the English boy as compared to the American: Unless the English boy has materially changed since I lived in England, I believe every word of what you quoted as having been said about him. As I have had occasion to say before, the American boy is educated, the English boy is trained; and this tells the whole story.

Syracuse, N. Y. JOHN E. SWEET.

Turning Hard Lathe Center with a Carborundum Tool

The dead center on my lathe was in bad shape. I got a hurry-up job where a ½-inch mandrel had to be used. As we have no center grinder, it seemed as if annealing and re-turning was the only way out. I happened to think of a worn-out carborundum wheel we had, No. 40 grain. Taking out the tool post, I bolted the wheel flatwise in its place on top of the compound rest and swung it around to 60 degrees; running the belt on the highest speed cone, I fed the wheel back and forth along the center, using the cross-feed screw to force the wheel in. In a short time my center was in good shape, in fact better than it would be after turning

and hardening, as it usually springs some in that process.

It is not recommended as a substitute for center grinders; but if owners of small shops who have no grinder or cannot afford the expense of one will try it, they will find it a fair substitute. After you get through with grinding the center in the way stated, a piece of fine emery cloth and oil put over a flat file makes a fine polish on the center.

Ross, Wyoming. H. F. J.

A Punch and Die with Automatic Lever Feed

At one time we had a great deal of trouble with the ordinary solid punches and dies for punching holes and slots in strips of sheet metal which were 18 inches long, and which were used for automobile cooler fronts. These pieces were punched in two operations by means of two solid punches and dies. The first operation cut the hole and the second operation the slot. As a result every two or three hours a diemaker would have to overhaul the tools because of a broken punch or a bur on the work, or for some other similar reason. Between the operation of punching the holes and the slots, and after the final operation, each piece of metal had to be straightened, as it came out of each set of press tools bent almost to a semicircle.

The old-fashioned lever feed also caused trouble and had to be bent sidewise every time it was adjusted to different widths of stock, in order to bring the pawl central with the punching. Again there were no stops for the lever for different feeds, and the setting of the cam was entirely by guess-work.

A new foreman was hired for the tool room; in a very short time he discarded entirely the press tools which had been used for this particular job and made a new split die and punch with an adjustable automatic lever feed. The results are now as satisfactory as they were before unsatisfactory.

Referring to Fig. 1, the die *A A* is made in two sections (that is, a split die) to fit in the dovetailed slide in a cast-iron holder *B*; each half is held by two screws *C C* which also serve for the purpose of adjustment. When the die becomes worn, it is taken from the holder and ground on the inside only, until it fits the test gage *D* of Fig. 2. On top of the die sections are fastened cast-iron plates *E E* having a T-groove in their upper face to guide the strips. On each of these plates is arranged a cast-iron roller *F* which runs free in its bearings and is held in position by an I-pin controlled by spiral springs. These rollers keep the metal pressed into the guiding grooves in the plates *E E*. The strip is fed from a spool at one side of the die and is cut to

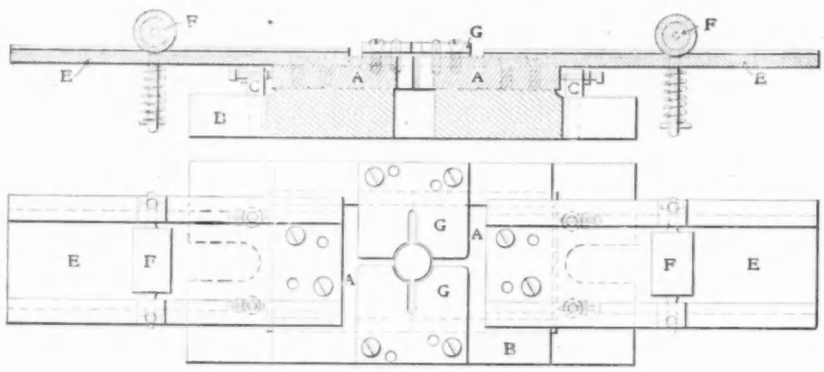


FIG. 1. A SPLIT DIE FOR AUTOMOBILE COOLER FRONTS

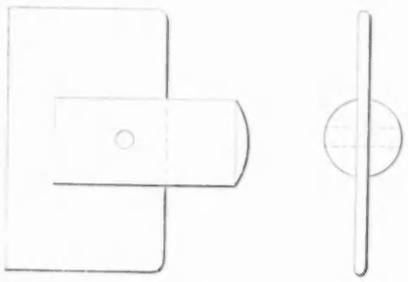


FIG. 2. GRINDING GAGE FOR THE DIE

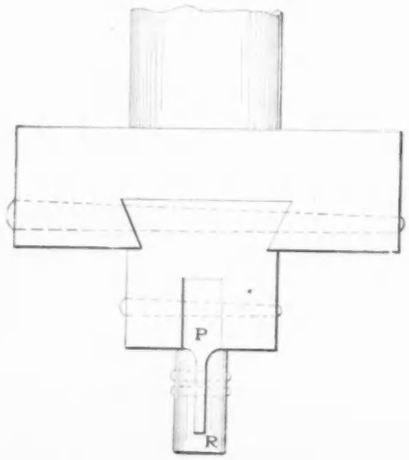


FIG. 3. THE SECTIONAL PUNCH

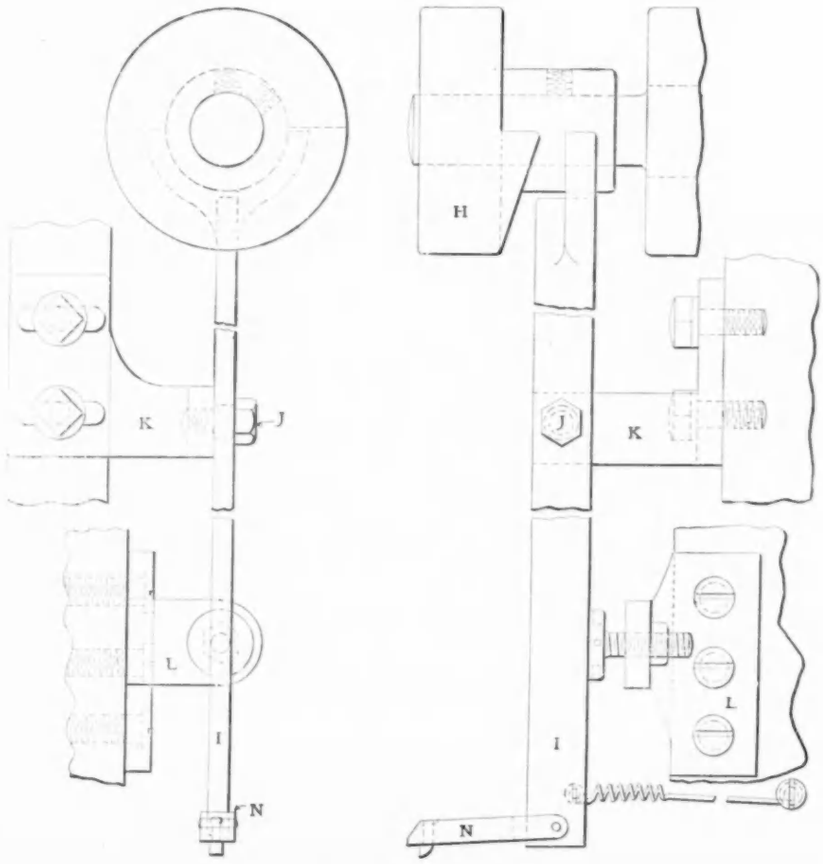


FIG. 4. THE AUTOMATIC LEVER FEED FOR THE DIE OF FIG. 1

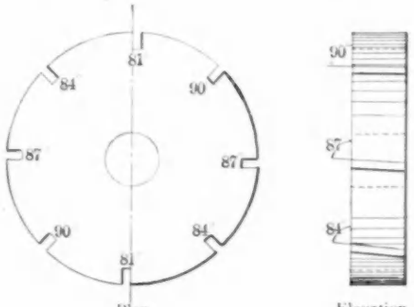
length with a pair of hand shears when it issues from the other side. The strippers are indicated by the letters *G G*. Referring to Fig. 3, *P* and *R* are the two punches, which are held together and into the punch holder by means of taper pins.

The automatic lever feed is shown by Fig. 4. In this the cast-iron cam *H* has a throw of one-half inch and is fastened to a stud on the press frame by means of two screws. The lever *I* is fulcrumed from the bracket *K* by means of the screw *J*. This plate *K* is adjustable by means of slots, as shown. In front of the press is a second angle clip *L* which has a stop screw *M*. On the extreme end of this lever is a finger pawl *N* which is a free fit in the lever so that it can slide over the metal when being pulled back and be in a position to drop into a hole just before the feeding stroke.

New Haven, Conn. R. A. ALMOND.

Stopping Chatter on Large Boring Heads

Readers of the AMERICAN MACHINIST who have had experience in boring out large cast-iron cylinders with boring bars



STOPPING CHATTER ON LARGE BORING HEADS

and traversing heads will know what a difficult job it is to stop the chatter or vibration on the cutters when once started. Packing wedges, inserted in the spaces between the cutters, is the most common way used to stop it; but even these are very unsatisfactory, as the wood wedges quickly wear and the chattering does not diminish, each cutter following in the path of the preceding one.

The best method of overcoming this difficulty is to core, or mill, the cutters out at a slightly different angle to each other, as marked in the accompanying sketches, varying about two degrees or three degrees, the two opposite slots being the same angle, as shown in the plan. The cutters do not all follow the same path then; should one commence to chatter, the next or following cutter, not being at the same angle, does not follow exactly the same cutting line as the preceding one and tends to neutralize the vibration and at the same time keep the boring bar steady. Those who have not tried this kink will find it will well repay them when making new boring heads.

Birmingham, England. J. GREEN.

Templets for Milling-machine Platens

The line cut shows a handy addition to the usual collection of data in a drawing room. As every draftsman engaged on tool work knows, it is a great advantage when designing milling fixtures to know the exact position the work will occupy on the table with relation to the edge and consequently with the cutters; nothing is more annoying than to have to make periodical excursions to the shop to measure up the various machines in use. A series of wooden templets such as the one illustrated, corresponding to a cross-section of the table and showing the T-slots, will distinctly facilitate matters in this respect; by laying them on the drawing it is easy to locate the tongues wherever required. Each templet should, of course, be marked distinctly with the name and number of the machine it corresponds to.

TEMPLET FOR USE IN DRAFTING ROOM

Marquette, Mich. S. W. MILLS.

Combined Boring and Threading Tool

The illustration shows a combination boring and threading tool that was used to very good advantage in a shop where I once worked.

The back part of the tool, of which the sketch is a top view, was ground to be used as a boring tool with the lathe running backward, and the front part for threading. The work was small brass caps, of which small quantities of odd sizes occasionally came along. While for the regular sizes we had better tools, there were not enough of the odd sizes to warrant the outlay for special tools. We had

A BORING AND THREADING TOOL

nothing but the ordinary lathe to turn them in; this always meant two tools and two settings for each piece, and calipering the thread and hole for each one chased and bored. With this tool we used two stops for the tool slide, one in back and one in front, when it was only necessary to be sure the first piece was right; the rest had to be. The stop for boring was made so it would swing back; when the hole had been bored to size, it was undercut at the back to allow the thread to run out.

P. A. FREDERICK.

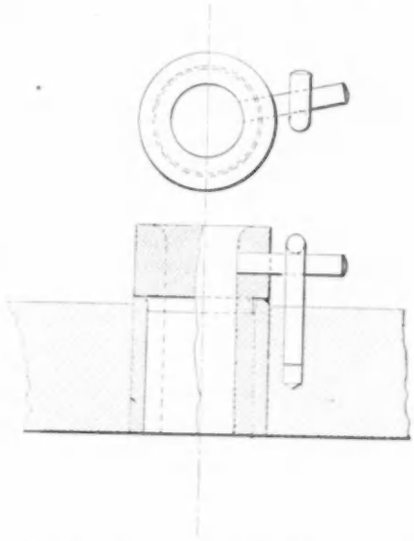
Kalamazoo, Mich.

Movable Bushings

I notice, on page 594, an article under the head of "Movable Bushings," by Wm. Metzroth, and beg to offer one or two suggestions based on the data that I have gotten together on this feature of tool design.

In the first place he states that all bushings should be made of tool steel to give the best results. I have used both tool steel and open-hearth steel with equally satisfactory results, the latter of course being case-hardened; if there is any preference, it is in favor of the open-hearth steel, from the fact that it seems to have less tendency to change shape in hardening.

There is also a use to which the removable bushing is often put, not mentioned by him, namely, where a number of holes in a piece have to be drilled and



CONSTRUCTION OF MOVABLE BUSHINGS

counterbored, which is often the case in automobile work. The holes are then drilled and the bosses faced in the same jig.

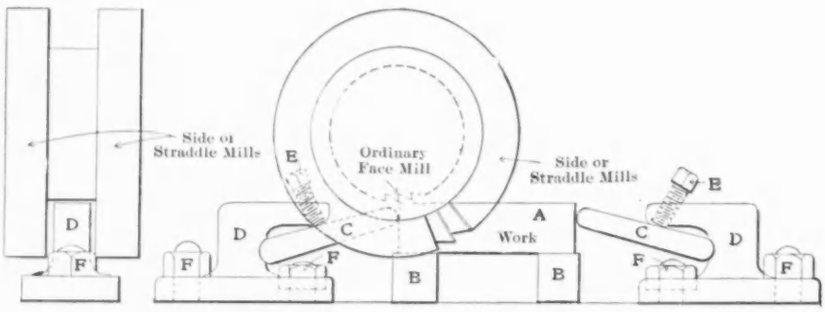
In regard to the method used for holding the movable bushing in place, I would say that I think his method a rather expensive one and no better than the common knee pin driven into the jig with a straight pin in the bushing locking under it, and held there by the turning of the drill, as shown in the sketch. This method gives greater ease in removal of the bushing, as I believe the nurled portions of his removable bushings are far too narrow to be easily grasped, especially when they are well covered with oil. We make the nurled top of all our removable bushings at least 5/8 inch high, unless prevented by lack of space.

I also note that he makes all his permanent or stationary bushings of the shoulder type. This is a much more expensive type than the one shown in the sketch, and it will be found for all the more common sizes of holes, where a reasonable thickness of bushing plate is feasible, that a permanent bushing of the plain type will work fully as well as a shoulder bushing in connection with a removable bushing. There are a number of instances where we want to use bushings so close together as to necessitate the removable bushing being very thin walled. In such cases I have found that much better results in hardening are obtained by omitting the little recess for grinding and throwing a small radius under the head of the removable bushing, similar to that on the stationary bushing.

Detroit, Mich. M. R. KAVANAGH.

A Toggle Clamp

A short time ago I was put in charge of a machine shop where we were milling a large quantity of pieces of steel ranging from ½ inch to about 1¼ inches square by about 10 inches long; and flat pieces about ½ inch thick and 1½ inches wide; these pieces were milled in an ordinary milling-machine vise on a plain miller, one side at a time. I noticed it took quite a minute or two to get the stock down properly upon the packings to make a nice parallel job, especially when the stock was not rolled square. At the time we were hard pressed for these pieces, and having no more milling machines at my disposal, I set to work and designed the accompanying toggle grips. *B B* are two pieces of steel bolted to the machine table. To insure our work being correct, we take a light cut over the tops of the pieces *B B* (before starting up on a fresh lot of work).



A TOGGLE CLAMP

D D are two pieces of steel, machined out of the solid as shown, and bolted to the table by the bolts *F*, the two inside bolts being sunk into *D D* so as to allow the toggles *C C* as much movement as possible.

The way we use it is first to bolt *B B* to the table; then bolt one toggle-grip body *D* to the table, holding the toggle *C* well up to the top; then bolt the other body *D* to the table so that *C* will just slide in place easily when the piece of work *A* is in its place; screw down the two set-screws *E E*, which causes a forward downward action through the toggles *C C* and forms a most satisfactory method of clamping down the piece to be milled.

The great advantage of this type of grip is that you are able to mill two or three sides at once, as you may require. We find that by using two straddle mills we get a good square job, which we can easily guarantee within a limit of 0.002 inch. The results we obtained were much better work in about one-third of the time, far less trouble in setting up a piece of work, no knocking the work down upon the packings, no cut across to see if the job is parallel, etc.

After a short time we were well ahead with this work, and I had to find other work to keep the machine occupied. I may say that the charge hands both on the millers and planers are using this type of grip on quite a number of jobs very successfully.

Birkenhead, England. A. E. R.

A Problem in Milling

Some time ago it fell to my lot to design a line of lathe chucks and the necessary jigs and fixtures for producing the parts in quantities so that they would be interchangeable.

Fig. 1 shows a jaw mounted in a milling jig. While thinking out the best method of machining the faces *F F F*, I was struck by an idea which, though I could not use it for this work (our millers not having enough power), will be applicable to other jobs. It is necessary that faces *F F F* be machined to the sizes given in Fig. 1 (the gripping parts of the jaw *D D* need not be touched with the milling cutter, as they are turned in the lathe in the next operation), and for the sake of economy all three faces must be machined at once, three cutters being mounted on the milling-machine arbor.

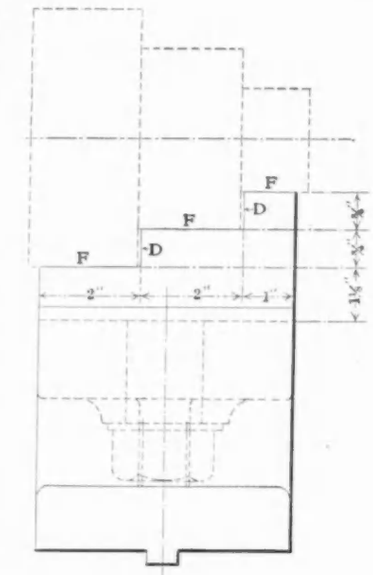


FIG. 1

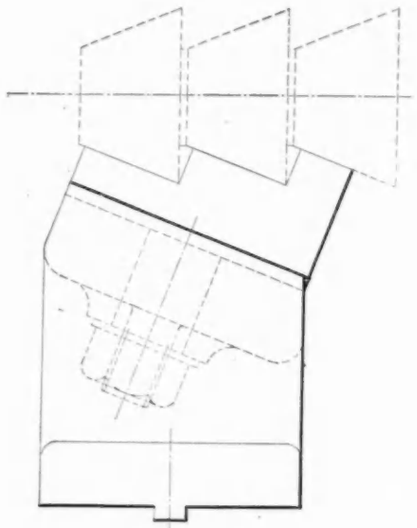


FIG. 2

A PROBLEM IN MILLING

The first method I thought of was the one shown in Fig. 1, which would, I think, be the method used nine times out of ten for such work. To do the job in this way we shall require to have the biggest cutter 3 inches larger in diameter than the smallest cutter, so that if the latter be only 2 inches diameter the large cutter will require to be 5 inches diameter. Driving a 5-inch cutter through steel will take a lot of power; the smaller cutters will be cutting too slow because they have to run at the same number of revolutions per minute as the 5-inch; or else the latter will have to be run too fast, to bring the smaller cutters nearer to their correct cutting speed.

The largest cutter is too large, and the disparity between the largest and the smallest is too great; but how can it be

done any differently? There are two steps, each ¾ inch deep; therefore the largest cutter must positively be 3 inches bigger than the least.

It was at this point of my meditations that I had an inspiration, and I discovered that it was possible to mill the three faces *F F F* all at once, with three cutters on the milling-machine arbor all exactly alike.

Fig. 2 shows how it is done; and I think the solution is correct for the conditions set, because all the cutters are exactly alike even though they are angular cutters. Whereas in Fig. 1 the variation in size of the cutters was 3 inches, in this one it is slightly less than 1½ inches; also where the diameter of the largest cutter in Fig. 1 is 5 inches, in this it is only 3½ inches, so that the speed of the spindle may be increased 40 per cent., which, if the feed per revolution remains the same, will give a 40 per cent. bigger output.

As I stated above, it wasn't feasible for me to use this method owing to the lack of power in our millers, but it may prove useful to some of the readers of this journal whose equipment includes powerful millers and whose product is similar to the chuck jaw.

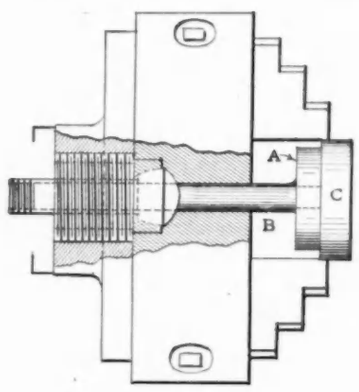
J. RACQUET.

Rugby, England.

Chucking Thin Work

Here is a handy lathe kink for holding thin work in a chuck.

In this *A* is a drive fit on the ⅝-inch shouldered gun-rod piece *B* which is held in a spring collet, then adjusted to the proper length relative to the chuck jaws and faced true. The work *C*, which is held in a three-jawed universal chuck, is firmly pressed against *A* while clamping



CHUCKING THIN WORK

the chuck jaws, and then faced as required.

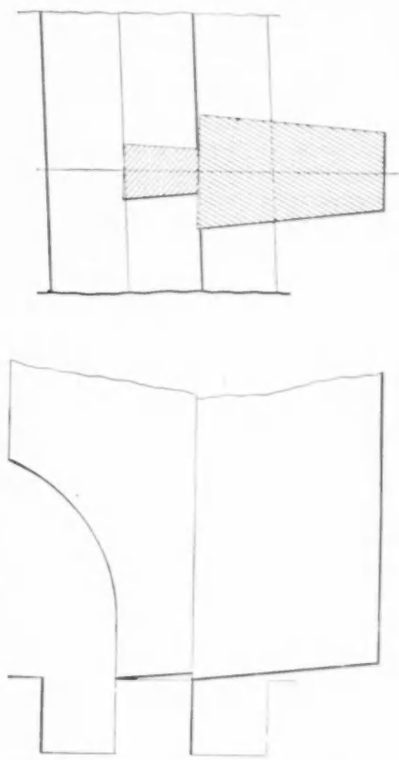
Collars, washers, packing rings, etc., up to 10 inches in diameter can be handled and faced very rapidly by this method and within a very small limit or fraction of a thousandth of an inch of being true.

Where a lathe is not provided with spring collets, the same results can be obtained by fitting a rod similar to *B* to the taper sleeve which is used in the head or spindle of the lathe.

Detroit, Mich. C. SHERWOOD.

Planing a Keyway in a Hard Screw

The planer gang of a shop was seized with consternation, each one fearing he would have to plane keyways in two screws. Ordinarily such a job would cause no comment, but these were



PLANING A KEYWAY IN A HARD SCREW

specially hard and tough; it had been barely possible to cut the threads, and for that reason the "smart" ones predicted the destruction of the planer on which the job would be attempted. One of the gang happened to be a mechanic, and he undertook the job, not, however, with fear and trembling. In front of the tool commonly used for such purposes he placed another, half the width, with the edge ground back so that the distance between the cutting edges was equal to the width of the thread or space, which were equal. Care was taken to have the edges cut to exactly the same depth. The sketches should make the arrangement clear and show that, under the conditions named, one tool is cutting while the other crosses the space, making the load on the machine practically uniform and avoiding the clatter usual with such jobs. The job was finished without mishap, and the smart ones said, "Anybody could do it that way."

Swissvale, Penn. JAMES BELL.

Size of Stock for Bolts with Rolled Threads

I am interested in Mr. Webster's article on page 630 in regard to bolts with rolled threads. I would like to have him try his formula on a small size of wire, say 0.0625 inch in diameter, and see if it works out correctly. Here is an experience which I have recently had.

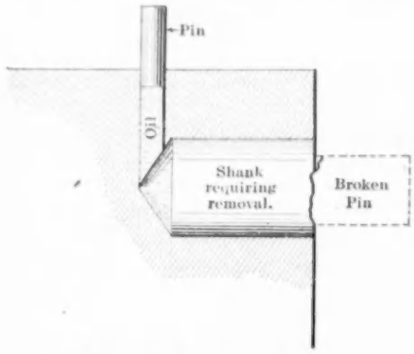
The finished diameter must be 0.0625 inch for a particular screw; by using his formula I find that the wire diameter should be 0.0552 or 0.0553 inch. This result I get from all available formulas, including Mr. Webster's. This size of stock I have very carefully tried, with the result that it is 0.002 to 0.003 inch too small. By the "cut and try" method I have found that the best size of stock for the purpose is 0.0585 inch in diameter. The pitch of the thread is 88. Has Mr. Webster had experience in rolling a thread as fine as this, and if so, will he kindly give us the benefit of his observations?

Winsted, Conn. S. A. GORMAN.

Removal of Stop-pin Shanks by Hydraulics

A well known screw machine has a series of hardened stop pins inserted in the end of a revolving cylinder, and the breaking of these pins is a source of considerable annoyance to both operator and tool room; perhaps not so much the mere breakage, as the difficulty of removing the broken shank which is left in the cylinder.

Our custom was to go after them with



REMOVING A BROKEN PIN

a chisel and remove them as best we could, damaging the cylinder to a greater or less extent—usually greater—as the shanks are made quite a snug fit. Finally an unusually obstinate shank, the end of which had become somewhat upset, and the hole badly burred, seemed to demand annealing and removing the pin by drilling.

Suspecting a cavity to exist at the bottom of the hole in the cylinder, we drilled a small hole clear through to the cavity and filled the entire space with machine oil, being careful to exclude all air bubbles. A nicely fitted wire was next inserted in the drilled hole and struck a smart tap with a hammer, when the obstinate shank flew halfway across the tool room. We now have all our cylinders drilled in this manner and the tool room is no longer called upon to dismantle machines and remove pins, the operator removing them readily himself.

This kink in hydraulics may be made use of to advantage in many other places beside screw machines.

Bradford, Penn. W. G. H.

A Multiple Punch and Die

The accompanying illustrations are of a multiple adjustable punch and a built-up die recently made to be used on a small inclinable Toledo Machine and Tool Company press for punching 1½-inch square holes. The press itself was, of course, carefully adjusted before the punch and die were placed on it for use. It is my intention not only to show the design of this punch and die, but to emphasize as well the nice workmanship used in its making, as results proved.

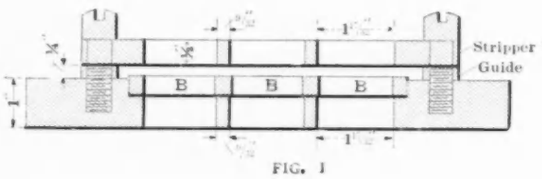


FIG. 1

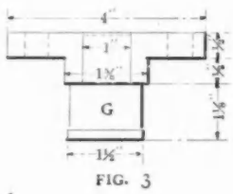


FIG. 3

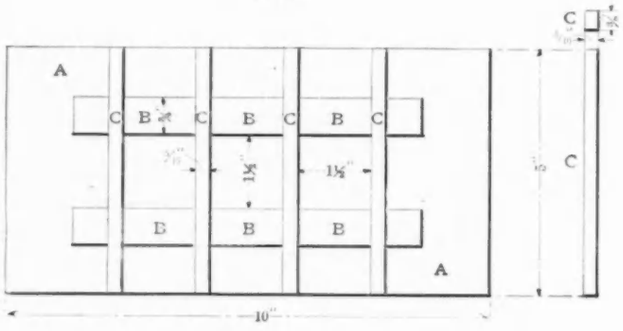


FIG. 2

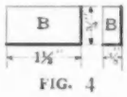


FIG. 4

A MULTIPLE PUNCH AND DIE

The body of the die *A*, Fig. 2, was made of soft steel; after being planed to the approximate sizes and the three holes cut through it 1/32 inch larger than the size of the punch, to allow the punchings to drop out, it was taken to a milling machine and grooves carefully milled to exact size and spaced exactly as wanted. In these grooves were fitted hardened pieces of tool steel *B* and *C*, Figs. 2 and 4, ground to exact size and secured in place by small screws (not shown) coming through from the bottom of the body of the die, the tool-steel pieces having been drilled and tapped previous to their hardening. Outside the outer, or end, pieces *C* were placed strips of ¼x¾-inch cold-rolled steel to serve as guides for the work, the stripper being fastened on top of these strips. The assembled die, with guides and stripper in position, is shown in section, Fig. 1.

The construction of the adjustable punch is shown in Figs. 3, 5 and 6. In the punch holder D, Fig. 5, is the pin *E* which enters the bore in the head of the press. The punch holder is also secured by cap screws at both ends to the head of the press. The hardened tool-steel punches *G* were made on one end a press fit in the holders *F*, Figs. 3 and 5, which are secured to the platen by cap screws. The holes in the holders are drilled a little large for the cap screws, to allow for adjustment of the punches to the assembled die. The holders *F* are ground to lie flat on the punch holder *D*, which is also ground on both sides.

After pressing the punches into their respective holders, they were ground to fit the die correctly, and here it is desired to emphasize the accuracy of the work on the punch and die. Although the punches were made but 0.001 inch smaller than the size of the die, it was possible to put any single punch through any single hole from top or bottom, or by turning the punch any of the four ways; and the three punches, after being adjusted in multiple to the assembled die, would enter equally well end for end from the top or the bottom of the die.

This punch and die, we may, as consistently as the makers of a well known reamer, term a "paradox—adjustable yet solid," for after having punched 150,000 holes in ⅛-inch tar board, it showed no appreciable wear, was still doing its work in a satisfactory manner and was ready for another assignment.

Danesville, Ohio. H. R. G.

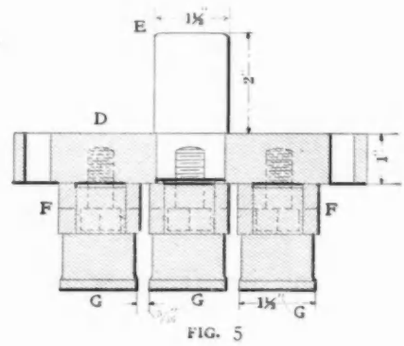


FIG. 5

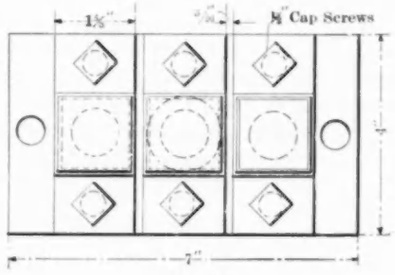


FIG. 6

Cost of Elevating Material

On page 651 there was an article stating that the power cost of elevating material is so small as to be negligible. This statement is supposed to be proved by a concrete example of 100,000 tons a year of 300 working days raised 25 feet, consuming 0.084 horse-power and costing $2.52 per year. To my mind that is liable to be very misleading.

In the first place there is a big difference in the kind of material, in its form, whether it is of a coarse nature, as coal or crushed stone, or of a finer nature, as grain or flour, and whether it is loose in bulk or in bags or barrels. For the first illustration we will suppose it is grain, loose in bulk, and we will raise it by means of a bucket elevator. One hundred thousand tons a year of 300 days equals 333⅓ tons a day of 10 hours, 33⅓ tons an hour, 0.555+ ton of 1110 pounds per minute; raised 25 feet equals $\frac{1110 \times 25}{53{,}000} = 0.849$ horse-power. Adding for friction of elevator alone would make it at least one horse power; if the material is coarse, considerable more must be added for the scooping-up effect of the buckets in the bottom of the elevator, a large piece being sometimes sufficient to stop or break the elevator.

For another illustration, consider a platform elevator and material in bags of 100 pounds each, allowing 5 minutes to load, 5 minutes to unload, ½ minute each to go up and down, 1 minute opening, closing, starting and stopping, so that one trip consumes 12 minutes, or 5 trips per hour. As we are to raise 33⅓ tons per hour, or 13,333.33+ pounds per trip, then we use

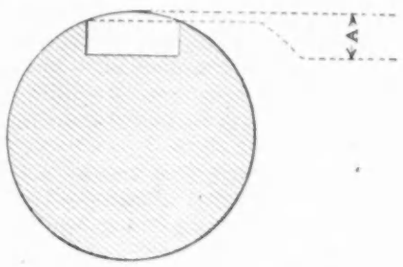
10.1 horse-power; adding 10 to 20 per cent. for friction, we will have 11 to 12 horse-power that it will be necessary to have ready 10 hours per day, although we only use that amount going up. That would be five trips per hour or 50 trips per day; ½ minute for each trip equals only 25 minutes per day that amount of power is used.

Brooklyn, N. Y. R. HOYT.

Table for Total Keyway Depth

This is a table which I find very useful in feeding the milling cutter down into a shaft.

Having the size of the shaft to be keywayed, look down the column marked "Size of Shaft" until you come to the number representing that size; then follow this line to the right until you reach the column representing the size keyway,



and the decimal there represented is the distance *A*, which added to the depth of the keyway will give the total depth from the point where the cutter first begins to cut.

C. WEBER BENNETT.

Iron and steel manufactures exported from the United States made their highest record in the calendar year 1907, the total being approximately 200 million dollars against 63 millions in 1897, and 16¼ millions in 1887. The value of iron and steel manufactures exported has increased more than 200 per cent. during the last decade, while that of other merchandise exported has increased less than 100 per cent.

Size of Shaft	1/4 Keyway	5/16 Keyway	3/8 Keyway	7/16 Keyway	1/2 Keyway	Size of Shaft	1/4 Keyway	5/16 Keyway	3/8 Keyway	7/16 Keyway	1/2 Keyway
1/2	0.0325	.....	.....	.....	.....	2 5/16	0.0068	0.0104	0.0155	0.0209	0.0274
9/16	0.0289	.....	.....	.....	.....	2 3/8	0.0066	0.0102	0.0152	0.0202	0.0267
5/8	0.0254	0.0413	.....	.....	.....	2 7/16	0.0064	0.01	0.0149	0.0198	0.026
11/16	0.0236	0.0379	.....	.....	.....	2 1/2	0.0063	0.0098	0.0146	0.0194	0.0253
3/4	0.022	0.0346	0.0511	.....	.....	2 9/16	0.0061	0.0094	0.0142	0.0189	0.0247
13/16	0.0198	0.0314	0.0465	.....	.....	2 5/8	0.006	0.009	0.0139	0.0185	0.0242
7/8	0.0177	0.0283	0.042	0.0583	.....	2 11/16	0.0059	0.0089	0.0136	0.018	0.0236
15/16	0.0164	0.0264	0.0392	0.0544	.....	2 3/4	0.0058	0.0088	0.0133	0.0176	0.023
1	0.0152	0.0246	0.0365	0.0506	0.067	2 13/16	0.0057	0.0086	0.0129	0.0172	0.0226
1 1/16	0.0143	0.0228	0.0342	0.0476	0.0625	2 7/8	0.0056	0.0084	0.0126	0.0168	0.022
1 1/8	0.0136	0.021	0.0319	0.0446	0.0581	2 15/16	0.0054	0.0083	0.0122	0.0164	0.0216
1 3/16	0.0131	0.0204	0.0304	0.0421	0.0551	3	0.0053	0.0081	0.0119	0.0161	0.0211
1 1/4	0.0127	0.0198	0.029	0.0397	0.0522	3 1/16	0.0052	0.008	0.0116	0.0158	0.0207
1 5/16	0.0123	0.0191	0.0279	0.038	0.0499	3 1/8	0.0051	0.0078	0.0114	0.0155	0.0202
1 3/8	0.012	0.0185	0.0268	0.0364	0.0477	3 3/16	0.005	0.0076	0.0112	0.0157	0.0198
1 7/16	0.0114	0.0174	0.0254	0.0346	0.0453	3 1/4	0.0049	0.0075	0.011	0.0149	0.0194
1 1/2	0.011	0.0164	0.024	0.0328	0.0429	3 5/16	0.0048	0.0074	0.0108	0.0146	0.0191
1 9/16	0.0107	0.0158	0.0231	0.0309	0.0412	3 3/8	0.0047	0.0072	0.0106	0.0143	0.0187
1 5/8	0.0105	0.0153	0.0221	0.0291	0.0395	3 7/16	0.0046	0.0071	0.0104	0.014	0.0184
1 11/16	0.0102	0.0147	0.0214	0.0282	0.0383	3 1/2	0.0045	0.007	0.0102	0.0138	0.018
1 3/4	0.0099	0.0142	0.0207	0.0274	0.0371	3 9/16	0.0044	0.0069	0.0101	0.0135	0.0188
1 13/16	0.0095	0.0136	0.0198	0.0265	0.0355	3 5/8	0.0043	0.0067	0.01	0.0133	0.0174
1 7/8	0.0093	0.013	0.019	0.0257	0.0339	3 11/16	0.0042	0.0066	0.0099	0.0131	0.0171
1 15/16	0.009	0.0127	0.0184	0.025	0.0328	3 3/4	0.0042	0.0065	0.0098	0.0128	0.0168
2	0.0088	0.0124	0.0179	0.0243	0.0317	3 13/16	0.0041	0.0064	0.0097	0.0126	0.0166
2 1/16	0.0083	0.0117	0.0173	0.0236	0.0308	3 7/8	0.0041	0.0063	0.0096	0.0124	0.0163
2 1/8	0.0078	0.0111	0.0168	0.0229	0.0299	3 13/16	0.0041	0.0062	0.0095	0.0123	0.0161
2 3/16	0.0073	0.0109	0.0163	0.0222	0.0291	4	0.001	0.0061	0.0094	0.0121	0.016
2 1/4	0.007	0.0107	0.0159	0.0216	0.0282						

TABLE SHOWING THE DISTANCE "A" IN CUT ABOVE, FOR KEYWAYS FROM ¼ TO ½ INCH IN WIDTH AND FOR SHAFTING FROM ½ INCH TO 4 INCHES IN DIAMETER. THIS DISTANCE IS ADDED TO THE DEPTH OF KEYWAY TO GET THE TOTAL DEPTH OF CUT FROM OUTSIDE OF SHAFT

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Jan. 23	20,000
Jan. 30	20,000

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Co-operative Engineering Education

The outlines of the plan of Professor Schneider for coöperation between the University of Cincinnati and the manufacturers of the same city in connection with engineering education have already been given in our columns. It will be recalled that the plan consists essentially of a division of the students into two sections which work in the shops and at the university on alternate weeks, each student of the first section having a mate in the second, the two taking one another's turn as alternates. The plan is somewhat similar to the half-time trade school plan of Professor Higgins, except that the shops and the university have no direct connection and the period of alternation is lengthened from half a day to a week.

The plan is now in its second year of trial and while this period is, perhaps, too short for a positive statement that the plan is a proved success, the experience acquired is such as to justify a high degree of optimism.

The university has maintained for many years a regular four years' course in mechanical engineering with a university shop for instruction in shop work. The new course is simply an alternative to the old one, the requirements for admission and the university work given being identical, except for the shop work, although the length of the coöperative course has been extended, provisionally, from four years to six.

The university exercises begin, of course, in the fall, but a valuable feature of the new system provides for a preliminary trial term in the shops beginning the previous spring and extending through the summer, the effect of which has been found to be a weeding out of undesirable students. The conditions of employment of the students in the shops are identical with that of regular workman except for the turn-about arrangement described and for the fact that the student-workman is put through various departments of the works beginning with the foundry in which he spends his first year—his first work in the foundry being that of a laborer at shoveling and wheeling sand. Needless to say, and apart from the weeding-out process, these conditions repel all but earnest students. It is, moreover, a condition that the student shall make good at the shops in order to continue his work at the university and, similarly, he must do satisfactory work at the university if his shop connection is to continue. Every effort is made to explain these conditions to all applicants and the growth of interest in the system is really inspiring.

For the first year opening in 1906, 75 applications were received, of which 45 entered upon the shop trial term, this number being reduced during the summer to 28, who entered the university in the fall, of which number 20 now remain as students. For the year opening in 1907, about 800 inquiries and applications were received. From this number about 60 were selected and this number entered upon the trial shop term. The weeding-out process reduced this to 44 at the opening of the university last fall, of which 40 now remain—most of the four withdrawals being due to financial reasons connected with the recent panic.

For the entering class of the present year, about 400 inquiries and applications have already been received which, judging by previous experience, means a total of about 2000 by the time the general selection comes around. The growth in interest is, in fact, so rapid as to make the accommodation of the students a serious matter. The funds of the university are limited and it is, of course, uncertain how many students the shops will be able to accommodate. Under these circumstances, the selection will naturally be of the most rigid character and admittance to this course bids fair to soon become a mark of distinction.

From the standpoint of the shops, it may be fairly said that the students are found to be satisfactory workmen, their enthusiasm and determination making up for any inconvenience which results from the weekly change of men. From the educational standpoint the results are remarkable. Except for the subject of drawing, in which the element of time is fixed, the half-time students are found to cover precisely the same ground per term as those in the regular course, and with a distinctly higher standard of scholarship. At the recent examination in chemistry, for example, 90 per cent. of the coöperative students passed the examination against 69 per cent. of the regular students, the two classes being examined together, and it is related that after examination week last spring, while the regular students were exhausted and in need of a rest, the coöperative students went back to the shops as though they had been through no unusual experience. It is Professor Schneider's belief, based on his experience to date, that the ground now covered by the regular students in four years will be covered by the coöperative students as well or better in five, the university shop work being, of course, omitted by the coöperative class.

One of the features of the coöperative course which attracts many of its students, is, of course, the opportunity which it offers for partial self-support The minimum scale of wages arranged with the shops is such as to insure total earnings during the entire six years' course of about $2000. Of this sum, about $400 are consumed in university fees, leaving the remainder for personal expenses. In some cases, however, the students have

been advanced beyond the minimum scale agreed upon.

The coöperative students have developed a spirit of skepticism and inquiry which is entirely new to the university. The lectures are now followed by a reversed quiz in which the professor is put upon the rack and they say that some of the instructors have found the situation very uncomfortable. The same spirit is carried by the students into their comments on the work done by the regular students in the university shop, the latter getting the merry ha-ha in a manner which they consider extremely rude.

The determination of these young men is well shown by a case in which six of them had entered a shop, after a change of superintendents—the superintendent in charge when they arrived having no knowledge of the arrangement and no sympathy with it when it was explained to him. The young men were put at work in the foundry and the superintendent gave orders to the foundry foreman to load those boys down until they gave up and quit. The foreman carried out his orders to the letter, but the boys did not quit, but hung to the most disagreeable and laborious work throughout the hot summer, with the result that the superintendent was completely converted to the plan and is now one of the most enthusiastic supporters. One of these boys suffered from gastric difficulties and was really not equal to the work, but he hung to it with the others, with the result that before the summer was over he developed the muscles of a blacksmith and the stomach of an ostrich.

We regard this as one of the most, if not the most, interesting educational experiment now in progress in this country. It is, we believe, one of those things which cannot fail and it may easily prove to be the beginning of an educational movement of as great importance as any in the past.

Simple Charts from Complex Equations

In this issue we publish an article on the design of hoisting hooks, which contains as a page insert a chart for determining the principal dimensions of a hook from a few general data. This chart, while perhaps appearing complicated, is very simple to use and gives all of the important dimensions necessary to design and proportion hoisting hooks throughout a wide range of capacities and sizes. It is plotted from an equation developed by Professor Bach for the stress in a curved beam. This equation, which is also given in the article, is rather formidable and complex, containing as it does several quantities, and the chart is a pleasing example of the way in which such a theoretical equation can be made of direct practical use to the shop man.

We would not criticize the average draftsman having to do with the laying out of hoisting hooks if he did not appreciate the possibilities in Professor Bach's equation for helping him in his work. Considerable mathematical training and time would undoubtedly be necessary in order to apply it properly. However, the chart developed from this equation is in such a form that it can be used by all.

Mathematical and experimental knowledge should be put in the form of charts and diagrams to a greater extent than it is done today, as it is a most serviceable method of using many classes of this knowledge; and knowledge in use is knowledge which has real value. In such form it is a saver of time and of brain energy. The results from its use are easily and quickly checked, with a feeling of security and an assurance of their accuracy which it is difficult to get from a long, laboriously worked out series of mathematical computations.

Data in such form occupy the same position to the designer that jigs and fixtures and special tools occupy to the machinist. They permit the production of a greater quantity of work in a given length of time, and with a greater degree of accuracy, than with the employment of more general methods. They are specialized appliances in their particular field and should be so considered. They should occupy a very important place among the working data of the engineer, designer and draftsman.

We have expressed our approval of diagrams in these columns before. The field for their development is wide. Much more can be done than has been done, and more and more of the store of engineering knowledge should be put into such a serviceable and efficient form.

Personal

Geo. M. Mayer, after an absence of about a year, has returned to Chicago and has established an office in the Old Colony building as manufacturers' agent.

A. W. Graham, of The Graham Manufacturing Company, and H. J. Burrough, of the Builders Iron Foundry, sailed on January 25 for a two months' trip in Europe.

L. H. Martell, who has been connected with the Garlock Packing Company, has recently organized and become president of the Anchor Packing Company, Philadelphia, Penn.

Hugo Diemer, who has been connected with the Goodman Manufacturing Company, has taken charge of the mechanical engineering department of Pennsylvania State College.

In a former issue it was noted in this column that F. R. Peirce was practicing patent law at Easton, Pa., which was in error, as Mr. Peirce has only been registered at Washington.

Egmont B. Arnold, until recently with the Power and Mining Machinery Company, has accepted a position as consulting engineer with the Engineering and Supply Company, of Milwaukee.

Walter B. Snow, of Boston, a former president of the New England Foundrymen's Association, now engaged as publicity engineer, was recently elected an honorary president of that organization.

F. V. McMullin, formerly general foreman of the forge department of the Westinghouse Machine Company, recently associated himself with the Cleveland City Forge and Iron Company as superintendent.

A. F. Roberts is now connected with Pawling & Harnischfeger in the capacity of mechanical and designing engineer. Mr. Roberts had formerly been in the employ of the Morgan Engineering Company for 18 years.

Obituary

George Chatterton, a pioneer in file making in this country, died at his home in Providence, January 18, having reached the age of 92 years. Mr. Chatterton began the manufacture of files in a small shop in Providence, R. I., in the year 1839, and has often been pointed to as the first manufacturer of steel files in this country. Mr. Chatterton came of a file-making family, having a long line of ancestors who were all engaged in the file-making industry in Sheffield, England.

George Vaux Cresson, the well known Philadelphia engineer and manufacturer, died in that city January 18, in his 72d year. In 1859 Mr. Cresson established the firm of Cresson & Hubbard, general machinists and lathe builders, after having learned the machine business in the employ of Bement & Dougherty. The firm made rapid growth, becoming an organization of large magnitude, and in 1892 was incorporated under the name of Geo. V. Cresson & Co., with Mr. Cresson as its president. For the last few years he had not been actively engaged in the business, holding the position of honorary president. Mr. Cresson always actively interested himself in philanthropic enterprises and his work in these affairs was well known and appreciated by a large circle of friends. He took a deep interest in the social side of business in Philadelphia, being prominent in many business organizations and having served as president of the Manufacturers' Club for three years. He was also a member of the Engineers' Club and the Franklin Institute. Mr. Cresson is survived by a brother and three nephews, all of whom are actively engaged with the Cresson Company.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

An Automatic Cam-cutting Machine

The illustrations show a machine for cutting cams from the smallest up to 20 inches diameter and having grooves for rollers as large as 3 inches diameter. The milling cutter and former roll are carried on opposite ends of a swinging arm pivoted near the floor at the back of the machine, as shown in Fig. 2. Two heads are dovetailed to the top of the bed, one at each end. These heads carry face plates. The spindles, to which the face plates are secured, rotate in unison, being driven by spur gearing through a suitable feed box driven by a single belt pulley, shown in Fig. 1. Both heads are movable to or from each other along the bed by means of suitable gearing and may be securely locked at any point.

The form roller is held against the form in the usual way by a weight, as shown. When it is desired to regrind the mill or remove the work, the work-carrying head is moved along the bed away from the mill by means of the hand wheel on the oblique shaft on top of the head. The hand wheel on the swinging arm has on its spindle a worm which engages a worm gear pivoted in the back of the swinging arm. This worm gear has a crank-pin in it. A link, jointed to the frame and projecting horizontally rearward from it, is provided at its end with a notch. This notch is engaged with the crank-pin on the worm wheel and the hand wheel is rotated; this swings the swinging arm outward and overcomes the action of the weight. Reversing this operation will bring the arm forward so that the form roll comes in contact with the former. By using the link and crank-pin, contour milling can be done without the use of a former, as with the face plate rotating slowly a line can be easily followed.

The formers for these machines are of cast iron ¾ inch thick and secured to a secondary adjustable face plate which may be located to correspond exactly with the cam to be cut.

The mill and the heads may be rotated automatically in either direction, and provision is made for conveniently changing the speed of the cam as the mill approaches or recedes from the cam center. The power feed is easily disengaged so that any form of line can be traced or followed by hand feed.

This machine is made by E. J. Manville Machine Company, Waterbury, Connnecticut.

An Engine Lathe

Fig. 1 shows the general appearance of the 24- and 28-inch sizes of a new line of heavy lathes.

The quick change gear box *A*, Fig. 1, is of the sliding intermediate gear type. The gear handle *M* is placed under the column of the index plate containing the desired thread and the handle *L* thrown down to connect up the gearing. The gear box *A* is supplemented by the box *B* on the stud plate. By the operation of a single lever *C*, four changes of gears are obtained in the ratio of 1-2-4-8, which with 7 changes in box *A* for each of these positions, make 28 changes, having a range from 2 to 28 threads per inch. By the changing of a single gear on the end of headstock, coarser or any special threads may be cut. Fig. 2 shows the mechanism removed from the box *B*. The studs carry-

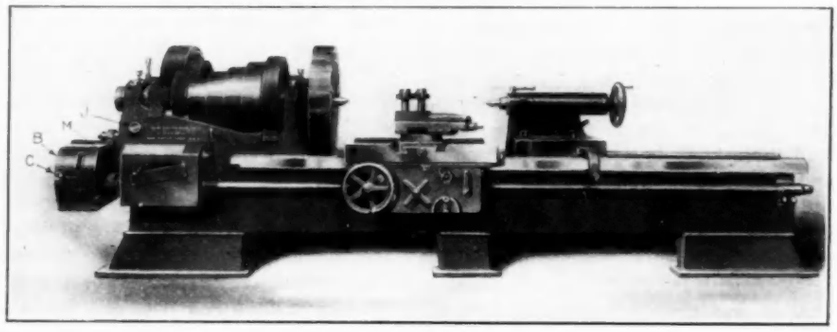


FIG. 1. AN ENGINE LATHE

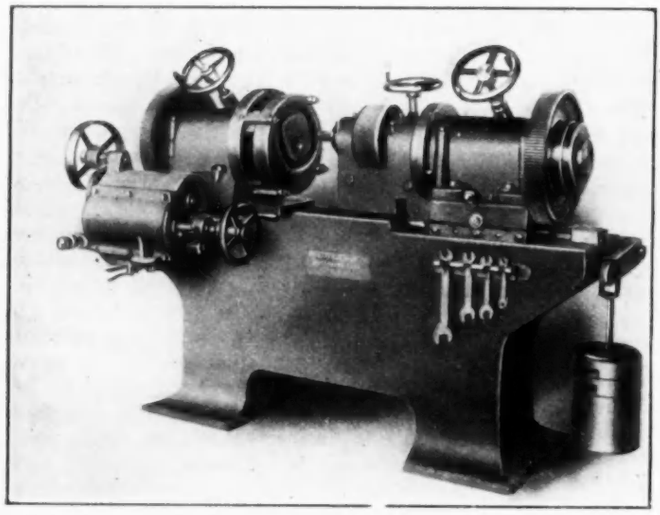


FIG. 1. FRONT VIEW OF CAM-CUTTING MACHINE

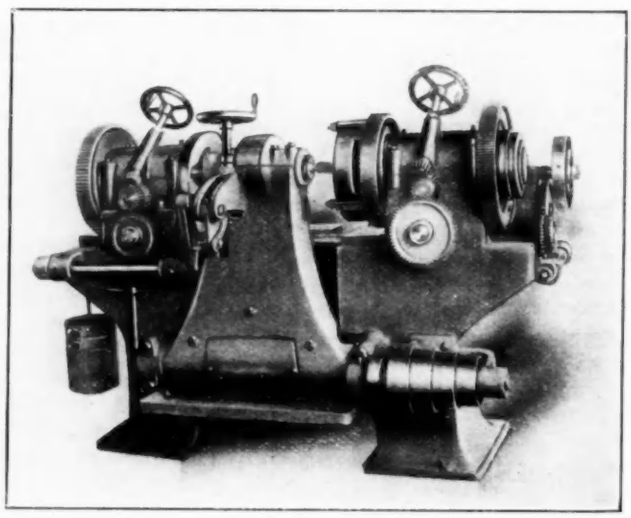


FIG. 2. REAR VIEW OF CAM-CUTTING MACHINE

ing the compound gears are held at each end in the steel yoke *D* which swivels on stud *E*. The handle *C* shifts the gear *F* on the end of the lead screw to the positions indicated on front of box, and also swings the gearing into mesh by an up or down motion.

The taper attachment, shown in Fig. 3, is supported on the back of carriage on a

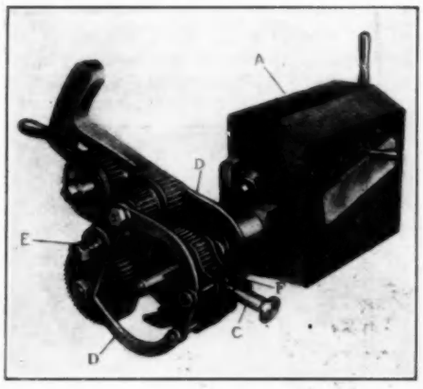


FIG. 2. THE CHANGE-GEAR BOX

bracket, the central part of which forms a complete box around the slide and swivel bar. *H* is a clamp to the rear of the bed and draws the slide relatively to the carriage. One end of the swivel bar is graduated in inches per foot taper, and the other in degrees. By removing the taper pin *I*, the cross feed screw is released from its driving pinion and left under control of the cross sliding block *K* which moves in or out in proportion to the offset of the swivel bar. By this arrangement the compound rest may be run in and out by crank on the front end of the screw while using the taper attachment, a very

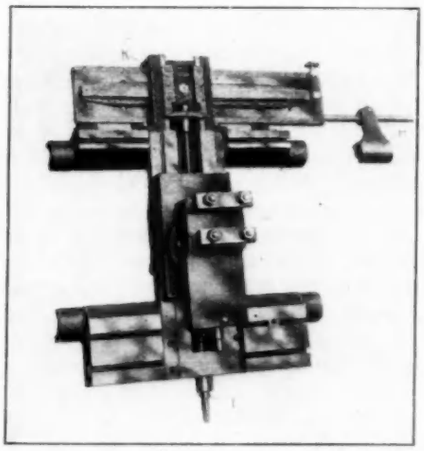


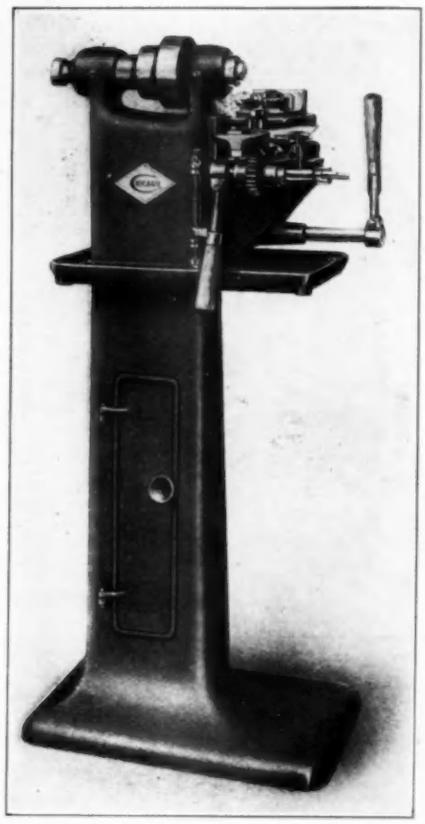
FIG. 3. THE TAPER ADJUSTMENT

desirable feature. In place of the quick change gear device the company is prepared to furnish a plain feed box having three instantaneous changes of feed obtained by throwing a single lever. These feeds are in the ratio of 1-2-4. These lathes have offset tailstocks allowing the tool block to be swung around parallel to the bed. The handle *J* in Fig. 1 operates the tumbled gears driving both the screw cutting and feeds. There is also a reverse in the apron for feeds. The spindle runs in adjustable taper boxes of bronze. Thrust is taken on ground bronze and hardened steel rings. The 28-inch lathe compound rest has angular power feed with a run of 10 inches.

The lathes are built by the New Haven Manufacturing Company, New Haven, Conn.

A Small Hand Milling Machine

The illustration shows a small hand milling machine which can be used either on the stand shown or on a bench, as pre-



A SMALL HAND MILLING MACHINE

ferred, the feet under the pan being for the bench support.

This machine is designed for gun, sewing machine, typewriters, locks, etc., where short milling and slotting are required, no back gears or overhanging arm being required. The bearings are self oiling and of ample proportions.

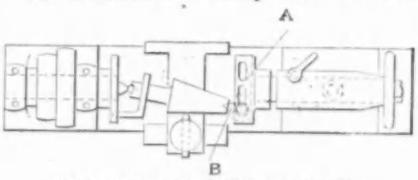
The spindle has a No. 9 Brown & Sharpe taper to which a sleeve is fitted to receive a drawing-in collet. The table feeds 9 inches in length, 2½ inches across and the knee has a vertical movement of 4¼ inches. The countershaft has two speeds, giving six speeds in all to the milling cutter.

It is built by the Chicago Machine Tool Company, Chicago, Illinois.

A Lathe Attachment for Turning Tapers

The illustration shows applied to a lathe a taper-turning attachment, patented by M. C. Zange, 2827 Sidney avenue, Cincinnati, Ohio.

The attachment *A* clamps on the end of

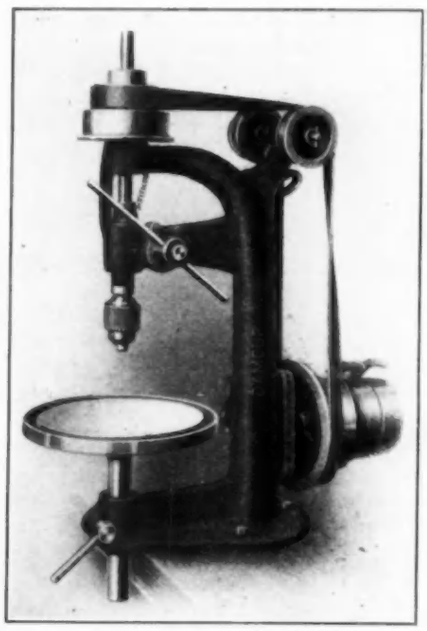


PLAN OF LATHE WITH WORK AND ATTACHMENT

the tail spindle; the center *B* can be set over the desired amount and swiveled to aline with the head center, which is of the shape commonly known as a "ball" center. When set over and swiveled the desired amount, it can be clamped tight. By the use of this attachment the alinement of the tail spindle need not be disturbed.

A 12-inch Drill Press

These drill presses are built in two styles, as a bench drill press, shown in the halftone and mounted on a column. The spindle has a ball thrust bearing, is



A 12-INCH DRILL PRESS

provided with a two-speed pulley, rack and pinion feed and an adjustable stop for drilling to depth. The pull of the belt does not come on the spindle, which is counterbalanced by a weight inside the column. The stop is applied to the pinion and not at the top of the spindle. The countershaft is secured directly to the frame of the machine. Greatest dis-

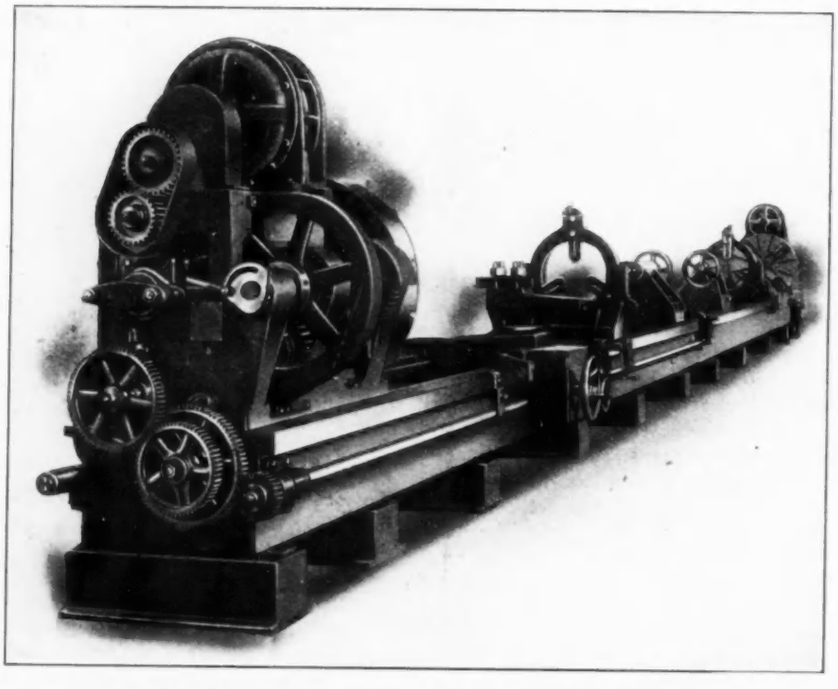
tance from spindle to table 8 inches. Vertical adjustment of spindle 2 inches and of the table 5 inches. Diameter of table 9 inches. Drill capacity 0 to 5/16 inch. These drill presses are made by Charles Ramsey Company, 135th street and Willow avenue, New York.

A Double-ended Forge Lathe

The Pond works of the Niles-Bement-Pond Company at Plainfield, N. J., has recently shipped to the Mare Island navy yard a large and heavy 48-inch lathe which has several points of interest. The illustration hardly does the machine justice, as it was so long that it was difficult to photograph in the limited space available; but it gives some idea of the length of the bed, which is 77 feet.

Used as two lathes, it will swing 28 feet between centers at each end; but by removing one tailstock and running the other one clear back, a piece 60 feet long can be handled. The double-lathe arrangement necessitates two lead screws, one being long enough to handle the carriage the full length of the bed and the other designed for only one end of the lathe. The cutting of such a lead screw is quite a proposition, as it is cut in sections, the first section being from the end of a bar up to say 3 feet of the other end, then a new section welded on, the cut portion supported out beyond the tail end of the lathe and the new section of the screw turned up and threaded, leaving enough for the welding on of the next piece. When it is considered that the commercial bars average about 20 feet in length, it will be seen that several welds are necessary. The lead screw is 78½ feet long, 2 15/16 inches in diameter and 1 pitch, single thread, as it is the Pond practice to use a coarse pitch for this purpose. It is also interesting to note that the Pond thread, which was used by them at least 25 years ago, is almost identical with the Acme thread, having the 29-degree angle and the other proportions very nearly the same.

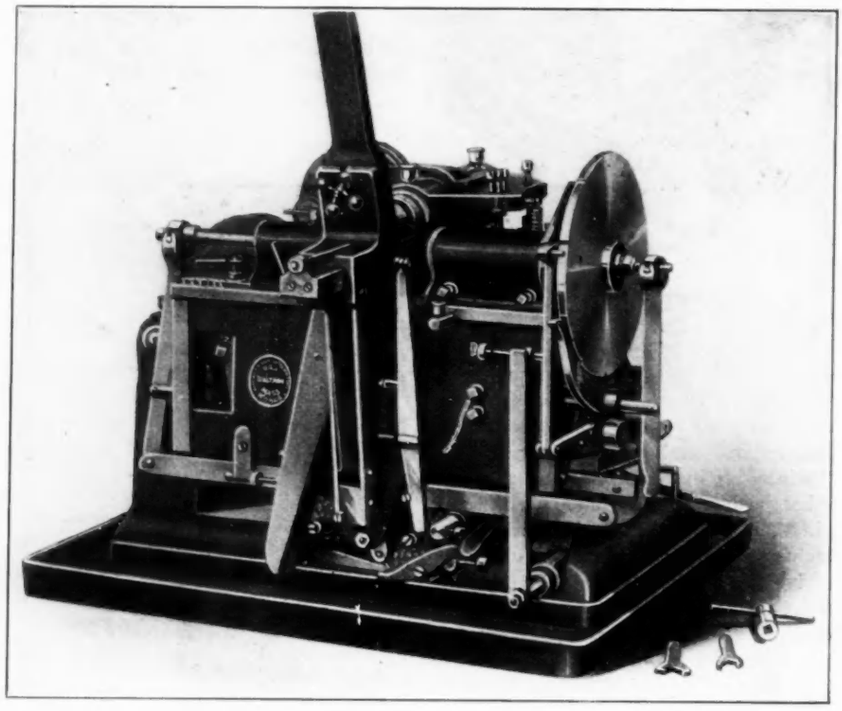
Each lathe head has a 30-horse-power, three-phase, alternating-current motor, wound for 60 cycles and 220 volts, which means that all speed changes are taken care of in the bead by gearing, twelve changes being obtainable in this way. Each face plate has four 12-inch steel chuck jaws for holding the work. The gross weight of material entering into this lathe was 130,000 pounds and the shipping weight 55 tons.



DOUBLE-ENDED FORGE LATHE FOR MARE ISLAND NAVY YARD

Automatic Pinion Cutter

The illustration shows the machine clearly. The blanks, previously made on an automatic screw machine, are placed in the magazine by hand, but all of the subsequent operations are entirely automatic. A taper hole in the head spindle holds one end of the blank while the opposite end is supported by a female center in the footstock spindle. The indexing of the work is obtained through a plate notched for the required number of divisions and operated by a cam. Extra indexes can be provided where several sizes of pinions are to be cut. The change from one index to another can be quickly made, it being necessary to adjust but one screw to secure the proper spacing of the indexing mechanism. The movement of the work slide is controlled by a cam and lever, the cam being cut so that a quick return is secured. The adjustment of the stroke is obtained through a connecting rod that can be clamped to the cam lever at different distances from the fulcrum of the lever. This connecting rod is fastened to the slide through a rack and pinion. The shaft of the latter projects through to the front of the slide and by it a longitudinal adjustment of the work in relation to the cutter can be obtained.



AUTOMATIC PINION CUTTER

The cutter spindle is carried in a swing that is raised during the return stroke of the work slide, thus allowing the index-

ing to be done without loss of time and also preventing the cutter from marking the work being carried through the cut at the increased speed with which the return stroke is accomplished. The cutter spindle is driven from a loose pulley running on the pivoting shaft of the swing, the connection being made by a train of gears. This removes belt strain from the spindle and allows the spindle to be lifted without slackening the belt. A coiled spring holds the swing in contact with a stop when the lifting cam is not in operation. Three cutters can be used on the arbor, a saw, a roughing and a finishing cutter. Three screws, one for each cutter, bear in turn against the stop just mentioned. This gives a separate adjustment for depth for each cutter. An adjustment of the stop will vary the depth of all the cutters an equal amount. The cutter swing is carried by a slide at right angles to the work and this slide is held by springs against three stops in succession so that the correct position of each cutter over the center of the work can be obtained. Two of these stops are in the swinging plate while the third, for the finish cut, is in the main casting.

The order of the operations is as follows: Starting with a blank in position between the centers and with the first cutter or saw in line with the work, the slide carries the blank forward and back beneath and in contact with the cutter, indexing the blank on each return stroke. When one complete revolution of the index has been made the stop plate is automatically rotated, thus allowing the springs on the cutter slide to bring it in contact with the second stop and the second cutter in line with the work. These movements are done during the return stroke after the last cut of the saw has been made. These movements are repeated after the second cutter has completed all of its cuts and so the finish cutter is brought to position and makes all of its cuts in turn. After the last of these cuts has been made and during the time taken by the work slide to return, the cutter slide is returned to its first position and the cut pinion is replaced by a fresh blank. The movements necessary to accomplish this are as follows: The footstock supporting center is withdrawn, the cut pinion is ejected, a carrier takes a fresh blank from the magazine and brings it into line with the work centers, the footstock spindle springs forward driving the blank into its socket in the head spindle and the carrier is returned to its position for receiving the next blank from the magazine.

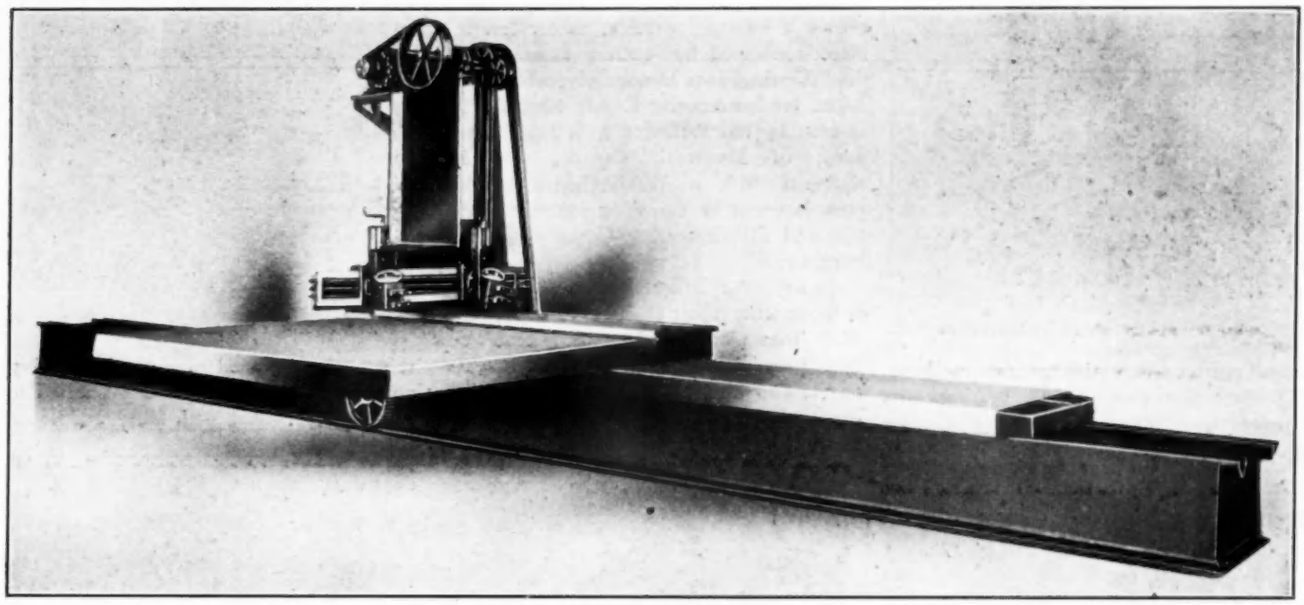
For many kinds of work it is not necessary to make three cuts, in fact in the majority of cases two cuts are sufficient and sometimes one is good enough. The machine shown was constructed for handling work where it was desired to get a cut as nearly perfectly smooth as possible, but the machine has been designed so that either one, two or three cutters can be used, cutting one, two or three times around the work. The adjustment of a single screw will make the change from three to two cuts and of two screws to one cut.

The magazine attachment can be removed and the machine used for hand feeding. When used in this way the turning of an eccentric is all that is required to make the machine stop automatically at the end of the last cut. The machine is made with hardened steel spindles, cams and other working parts. The builder is the Waltham Machine Works, Waltham, Massachusetts.

A 60-inch Open-side Planer Having a 52-foot Bed

The accompanying half-tone illustration shows a very large open-side planer recently built by the Cleveland Planer Works, Cleveland, Ohio. The bed is a single casting 52 feet long, 45 inches wide and 27 inches deep, cast closed on the upper side with the exception of the opening for the bull-gear. The walls are 1½ inches thick and are connected by cross partitions 1¾ inches thick spaced about 30 inches apart. Its weight is approximately 52,000 pounds.

The foundry work was so successful in making it that when the casting was cold and was supported in a normal position the bed was straight within one-quarter of an inch vertically and within one-eighth of an inch horizontally. One reason for making this bed as a single casting was to test the capacity of the foundry and to determine the accuracy of the calculated allowances to produce a straight casting when cold. It is believed that this is one of the longest, if not the longest single machinery casting ever made.



A 60-INCH OPEN-SIDE PLANER HAVING A 52-FOOT BED

The planer table is 31 feet long; its V's are 36 inches on centers and its rack has an 8-inch face, 2½ inches pitch. All of the gears are of steel.

The casting shown on the planer platen is the plate for a floor boring-mill base. It weighed approximately 22,000 pounds, being 12 feet square, nine inches deep and very heavily ribbed. It is interesting to note that it was finished in 26 hours; that is, planed top and bottom, including the slide which is undercut on both edges. When located on the planer the plate was balanced within about two tons.

Two Plain Milling Machines

Two plain milling machines, differing principally in size, have been added to the line of Van Norman tools by the Waltham Watch Tool Company, Springfield, Mass. These have been designed for rapid manufacturing which requires the use of high-

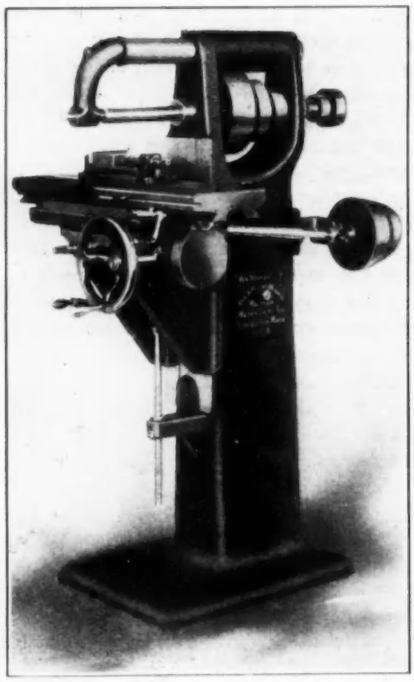


FIG. 1. PLAIN MILLING MACHINE

speed cutters and a stiff, accurate machine. To meet this, both spindle bearings are conical and when wear occurs can be taken up by one pair of take-up nuts at the rear. All bearing surfaces are large, to insure wear and alinement.

On the larger machine, known as A, the table has a feed somewhat out of the ordinary. When feeding automatically, the screw is locked and the nut revolves on it; but for hand feed, the screw is released and fed by hand in the usual way.

The table of the A machine has a rack and pinion feed with a quick return giving a 3-inch travel to one turn of the wheel. Both machines are supplied with an oil pump, and large oil channels are provided for the return of the lubricant.

The principal dimensions of the two machines are: Table feed, 13 and 18 inches; cross feed, 5 inches; vertical feed, 14 inches in both sizes; table, 24x7 and 28x8 inches; feed changes, 3 and 6; and weight, 850 and 950 pounds respectively.

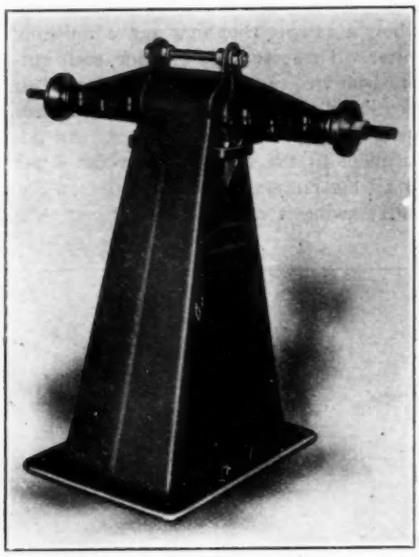
A Portable Motor-driven Lathe

The accompanying half-tone illustration shows a simple, portable, motor-driven, direct-connected bolt-cutting lathe styled the "Westinghouse Motor Driven Portable Lathe for Locomotive Repair Shops." It is built by the Williams & Wilson Company, of Montreal, Canada, and is equipped with a Westinghouse motor, manufactured by the Westinghouse Electric and Manufacturing Company, Pittsburg, Penn.

As its name indicates, its especial field is locomotive repair shops. It can be handled from place to place by a crane or moved on its own wheels. In use it rests on the two wheels under the head and the legs under the footstock. To move it the swiveling handle is pressed down, bringing the attached wheel in contact with the floor, and in effect the machine is on a three-wheeled truck. It may be fitted with either an induction or a continuous-current motor. Connection to a source of current is afforded by a flexible cable and plugs.

A Buffing and Polishing Lathe

The half-tone shows a buffing and polishing lathe designed specially for driving from below through the hollow base. The spindle is provided with tight and loose



A BUFFING AND POLISHING LATHE

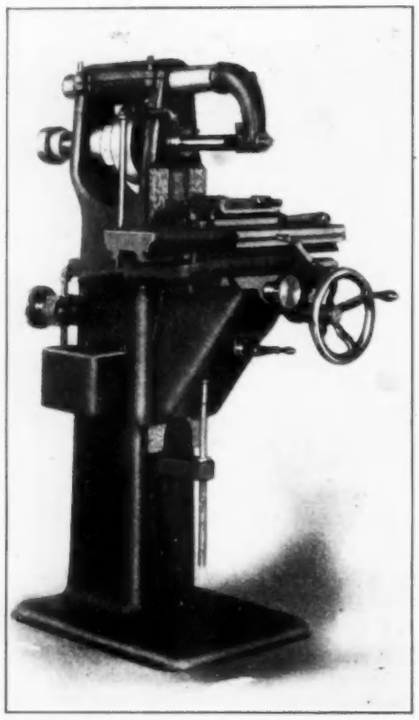
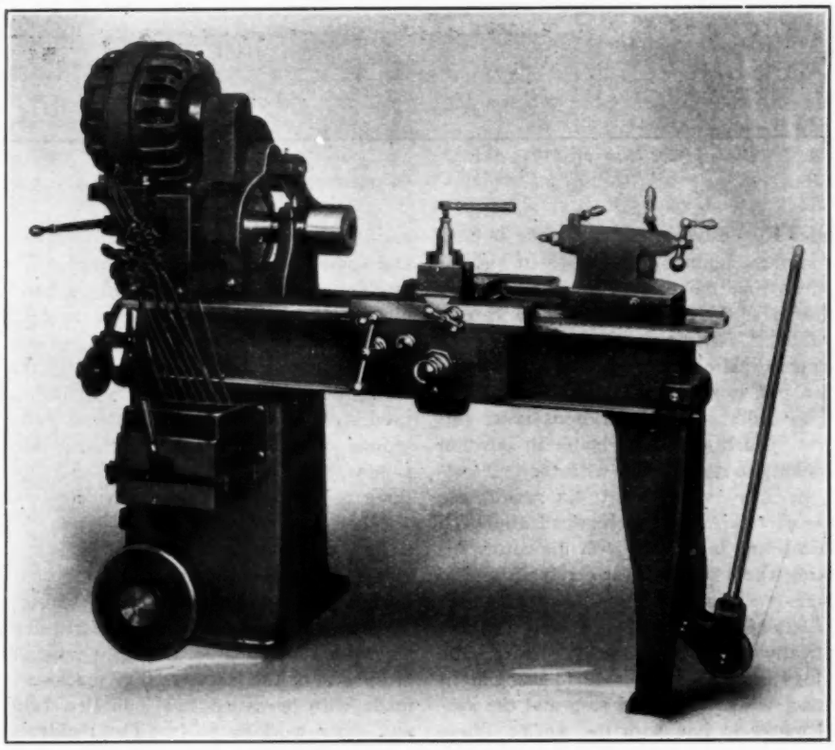


FIG. 2. PLAIN MILLING MACHINE



A PORTABLE MOTOR-DRIVEN LATHE

pulleys which are entirely covered, but which may be instantly uncovered when necessary by removing the cover plates.

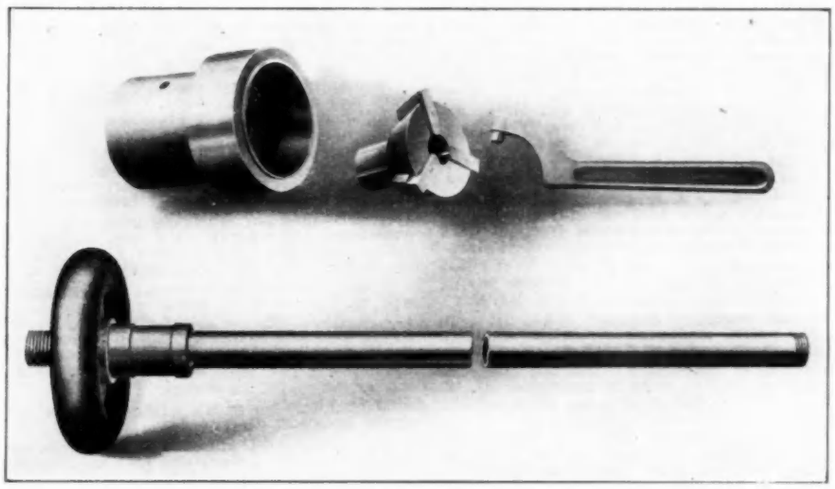
The bearings for the spindle are 14¾ inches long by 1¾ inches diameter. They are self oiling and are provided with oil reservoirs, the openings in which are ⅝ inch above the bottom of the bearings. The oil flows to the bearings through holes in the bottoms of them which are equipped with wicks.

The lathe is regularly built with a steel spindle 51 inches long by 1¾ inches diameter turned down to take wheels 1¼ inches in the hole.

These lathes are built by Webster & Perks Tool Company, Springfield, Ohio.

A Draw-in Attachment

The illustration shows a draw-in attachment suitable for any lathe with a hollow spindle. With this attachment a supply of collets is unnecessary as the three jaws shown are suitable for all sizes within the capacity of the tool. The hood



A DRAW-IN ATTACHMENT

is threaded to fit the spindle nose and the adjustable collet is fitted into the hood. Step jaws for castings and stock larger than the capacity of the spindle are also supplied.

This attachment is made to suit any size or make of lathe, by the Adjustable Collet Company, Cleveland, Ohio.

The first attempt to utilize the automobile on the battlefield is about to be made in Morocco in a newly invented automobile mitrailleuse. This has a 30-horsepower Panhard chassis, unarmored, on which a gun is mounted on a pivot in the center. The officer and chaffeur are placed in front and two artillerymen in the rear. The gun can be trained in any direction. The new automobile is under the command of Captain Genty, head of the military automobile park at Vincennes. It has arrived at Oran already and has left for the front.—*Horseless Age.*

Business Items

The Western Electric Company, Hawthorne, Ill., has added to its regular line of enclosed arc lamps the Beck flaming arc lamp.

The Rock Island (Ill.) Tool Company, report that business is very good and that they propose to begin operations on their new factory just as soon as weather permits. They have just shipped a large order of vises to the Panama Canal Commission.

C. W. Hill & Co., 201 Woodward building, Birmingham, Ala., has been made the special correspondent of the southern States for Pawling & Harnischfeger, Milwaukee, Wis., builders of traveling cranes and horizontal drilling and boring machines.

The Lumen Bearing Company, on January 3 and 4, observed its fourth annual gathering of office and sales forces at the Buffalo plant. The daily sessions were devoted to discussing business methods and plans, with an occasional paper on a subject particularly relative to bearings. The meeting wound up with a banquet given by the company, at which sixteen were present.

The Union Twist Drill Company, Athol, Mass., makers of milling cutters and twist drills, state business conditions are improving and that since the first of the year they have received a number of orders, several of them large ones, among which was one from the Washington navy yard for about one thousand of their high speed cutters. The Government requisition calling for bids on this material specified "cutters as manufactured by Union Twist Drill Company."

Trade Catalogs

Carr Brothers, Syracuse, N. Y. Circular illustrating and describing tool holders, cutting-off and side tool.

J. E. Snyder & Son, 100 Beacon street, Worcester, Mass. Catalog of upright drills. Illustrated, 52 pages, 6x9 inches, paper.

Electric Controller and Supply Company, Cleveland, Ohio. Catalog describing lifting magnets. Illustrated, 32 pages, 8x10½ inches, paper.

George Nash & Co., 217 Pearl street, New York. Pamphlet entitled "Hints to Practical Users of Tool Steel." 4½x7 inches, 58 pages, paper.

Standard Electric Accumulator Company, 141 Broadway, New York. Catalog describing Standard accumulator. Illustrated, 20 pages, 5½x7 inches, paper.

The Calculagraph Company, 9-13 Maiden Lane, New York. Treatise, "A New Idea in Time Recording and its Advantages in Cost Accounting," by Robert W. Higgins.

Northern Electrical Manufacturing Company, Madison, Wis. Booklet No. 54, giving some facts about the single voltage variable speed system. Illustrated, 12 pages, 3½x6 inches, paper.

The Murray Iron Works Company, Burlington, Iowa. Pamphlet, Series D. No. 7, entitled "Nomenclature of Murray Corliss Engines," containing line drawings with each part indicated.

United Engineering and Foundry Company, Pittsburg, Penn. Catalog of high speed saws for iron and steel works. Illustrated, 22 pages, 8½x10 inches, paper. Catalog of roll turning lathes. Illustrated, 20 pages, 8½x10 inches, paper.

Hyatt Roller Bearing Company, Newark, N. J. Bulletin No. 116, giving results of the substitution of Hyatt flexible roller bearings for ring oiling babbitted bearings. Bulletin No. 103, containing data showing friction load of shafting in an electrically driven machine shop when equipped with Hyatt bearings.

Manufacturers

The shops of the Erie Railroad at Hornell, N Y., will be enlarged.

H. E. Bumby, Bessemer, Ala., is erecting a new foundry and machine shop.

Phillip Dross, Meridian, Miss., contemplates establishing an iron foundry.

The A. Dale Houff Company, Terre Haute, Ind., will build a new planing mill.

E. J. Noblett Company, Chicago, Ill., will design and erect a woodworking plant.

The Weston Manufacturing Company, Manistique, Mich., will put up a planing mill.

The Jones Machine Company, Chattanooga Tenn., would like to receive catalogs for its file.

The Adamson Machine Company, Akron, Ohio, contemplates the erection of a new plant.

The F. A. Klaine Company, Cincinnati, Ohio., proposes to erect an addition to its stove foundry.

It is announced that the main shops of the Western Pacific Railway Company are to be erected at Sacramento, Cal.

J. T. and O. G. Burriss, Anderson, S. C., will establish a plant for the manufacture of a patented metallic shingle.

The paper mill of the Falls Manufacturing Company, Oconto Falls, Wis., recently destroyed by fire will be rebuilt.

The planing mill of Davis Bros., Akron, Mich., was destroyed by fire, causing a loss of $100,000. It will be rebuilt.

The plant of the Mountain State Boiler Works, Parkersburg, W. Va., which burned a short time ago, will be rebuilt.

The enameling shop at the plant of the National Conduit and Cable Company, Hastings, N. Y., was destroyed by fire.

It is stated that the Buffalo, N. Y., Machine Manufacturing Company is having plans prepared for a new factory.

The plant of the Queen City Furniture and Manufacturing Company, Shreveport, La., was destroyed by fire. Loss, $100,000.

The Iron Sanitary Manufacturing Company, Pittsburg, Penn., has had plans prepared for a new foundry at Zelienople.

The Idaho & Washington Northern Railroad will erect machine shops at Spirit Lake, Idaho, which with equipment will cost $100,000.

The Texas Oil Company, a subsidiary of the Standard Oil Company, will build a plant in Bayonne, N. J., which will employ over 2000 hands.

The Helix Separator Company, Minneapolis, Minn., has been organized by Peter K. Neilson to manufacture a cream separator, which he has patented. Capital $100,000.

Fire destroyed the machine shops, oil house and some of the stalls of the roundhouse of the Lake Shore & Michigan Southern Railroad, causing a loss of $125,000.

The Crescent Car Company, Lexington, Va., has been incorporated with $50,000 capital. Incorporators, J. H. Laird and M. J. Hess, of Lexington, and E. L. McGeown, of Guthrie, Okla.

The Houston (Tex.) Armature Works has been incorporated to manufacture meters, dynamos and electrical appliances. Capital, $10,000. Incorporators, F. E. Ward, L. R. Ward and E. T. Barden.

The Baltimore (Md.) Automatic Vending Company has been incorporated to manufacture vending machines. Capital, $25,000. Incorporators, W F. Lambdin, Nineteenth street and Edmondson avenue, N. Gist Lambdin, etc.

The Ross Motor Vehicle Company, St. Louis, has been incorporated with $75,000 capital to manufacture and deal in automobiles, motor vehicles, etc. Augustus Ross, T. A. Bell, Frank D. Gildersleeve, etc., incorporators.

The Gonder & Birch Company, Elm Grove, W. Va., has been incorporated to operate foundry and machine shop. Buildings and machinery will cost $10,000. William Birch, William Gonder and George Leinweber, incorporators.

The Edgar Manufacturing Company, Kansas City, Mo., recently incorporated, will rent a building for the manufacture of refrigerating and ice-making machinery at present and later erect a new plant. Address is 316-10 West Twentieth street.

The Washington, Westminster & Gettysburg Railroad Company has been organized to build a line 60 miles long from Washington to Gettysburg, Penn. J. B. Colgrove, Washington, D. C., is president, Walter Atlee, Baltimore, Md, chief engineer.

The Roanoke (Va.) Stamping and Enameling Company, incorporated a short time ago, will erect a plant for the manufacture of enameled kitchen utensils. Machinery will be installed at a cost of $18,000. I. M. Warren, president and general manager.

The Adamson Machine Company, Akron, Ohio, newly incorporated, will erect a plant to consist of machine shop, foundry, pattern shop and blacksmith shop. About $100,000 will be expended. W. E. Slabaugh, C. F. Adamson and R. B. Koontz are interested.

The Merchants and Miners' Transportation Company, Baltimore, Md., has awarded contract for the construction of a six-story building which will contain boiler and engine room, blacksmith shop, machine shop, etc. J. M. Blankenship, general superintendent.

The Gardiner, Worthen & Goss Company, Tucson, Ariz., is making arrangements to build another plant to replace the one recently destroyed by fire. The plant will be equipped for the manufacture of structural and general sheet work and a mine car of improved design.

The Schwene Manufacturing Company, of Ogden, Iowa, and the Perry Manufacturing Company, of Perry, Iowa, have consolidated under the latter name. Plans have been completed for a new factory at Perry for the manufacture of steel hardware, dies and special machinery.

Want Advertisements

Rate 25 cents a line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free.E.G.Smith Co., Columbia, Pa.

If you use small gears in large quantities, write Berry and Parker, Erie, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Estimates on patterns, models and wooden novelties cheerfully given. Ideal Pattern Works, Bethlehem, Pa.

Special machinery designed and built; duplicate parts, tools, jigs and dies. The Wade Machine Co., 133 Oliver St., Boston.

Special machinery accurately built. Screw machine and turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Mechanics write for our special offer of how to get a set of wrenches free. Bullard Automatic Wrench Co., Providence, R. I.

Wanted—Exclusive agency for first class tool, machine or appliance for district having Baltimore as base. Box 788, AMER. MACH.

Special machines designed and built; duplicate parts, model or experimental work. Mantle, Park ave. and 129th St., New York.

Automatic machinery designed; special purpose machines; working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Inventions, novelties, ideas, etc., developed; special machines designed. Albert Pott, M. E., 23 Platt St., New York, and Waterbury, Conn.

Air, ammonia compressors, steam, gas engines, turbines, centrifugal pumps, special machinery designed; inventions developed. Box 814, AMERICAN MACHINIST.

Have you any copies of December 12 and 19 issues of the AMERICAN MACHINIST? We will give fifteen cents for every copy that we can get. AMERICAN MACHINIST, 505 Pearl St., New York.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMER. MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg Co., Amsterdam, N. Y.

This offer will be withdrawn February tenth. Oregon Prospecting and Development Company owns three gold quartz claims, Baker county, Oregon; $1100 has been spent on our Gold Point claim; shaft down 40 feet now; ore averages $35 per ton; total cost of operation $3 per ton; no difficult conditions whatever; every assurance of $250,000 property by expending $20,000; we want men as stockholders who can afford to invest $100 for 500 shares treasury stock par value $1 per share, full-paid and non-assessable. I personally guarantee correct business management or to refund investment at end of six months if not thoroughly satisfied; my reference, Western National Bank, Louisville, Ky. Address Vincent R. Coon, President; general contractor, Louisville, Ky.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Graduate mechanical engineer; 10 years' experience as machinist, toolmaker, 3½ years' drafting; seeks position. Box 818, AMERICAN MACHINISST.

Assistant superintendent manufacturing plant 3 years; 5 years' previous experience in machine shop and drafting room; 32 years old; Yale graduate; member of A. S. M. E.; location, in or near Chicago. Box 732, AMERICAN MACHINIST.

First-class mechanic; 18 years' experience as toolmaker, tool room foreman and superintendent on typewriter and sewing machine work; desires position as superintendent or assistant; best of references furnished. Box 805, AMERICAN MACHINIST.

IOWA

Mechanical engineer, college graduate; 9 years' experience designing Corliss engines and coal mining machinery. Box 815, AM. M.

MARYLAND

Practical and experienced mechanical draftsman wishes to make a change. Box 819, AMERICAN MACHINIST.

Mechanical draftsman; eight years' experience; wants work with mechanical engineering and construction firm. Box 822, AM. M.

MASSACHUSETTS

Is your production slow and costly? Try another superintendent more up to date, expert mechanic, executive, good organizer and systematizer; wide awake with long and varied experience as superintendent; light or medium manufacturing preferred. Address "Expert," AMERICAN MACHINIST.

NEW JERSEY

Mechanic; 32; experienced at watch lathe work and assembling; used to handling male and female help, also experimental work. Box 808, AMERICAN MACHINIST.

Draftsman wishes change; technical graduate, three years in machine shop, total engineering experience, eight years; moderate salary. Box 801, AMERICAN MACHINIST.

A first-class patternmaker with ten years' experience on general machinery desires position with firm that requires a trustworthy mechanic. Box 817, AMERICAN MACHINIST.

A M. I. Mechanical engineer; Englishman; age 35;; 5 years' as works manager, steam, gas, hoisting and electrical machinery; seeks position as manager, superintendent or representative; executive ability and highest qualifications. Box 820, AMERICAN MACHINIST.

NEW YORK

Mechanical draftsman wishes position. Address Box 823, AMERICAN MACHINIST.

First-class mechanical draftsman experienced in boilers, cranes and hoisting engines; wants position. Box 807, AMER. MACH.

Mechanical draftsman; (single); 5 years' drafting experience; wishes position; willing to travel. Box 813, AMERICAN MACHINIST.

Draftsman, engineer; 9 years' good, varied drafting and shop experience; technical graduate; electrical, machine and general engineering. Box 809, AMERICAN MACHINIST.

Situation wanted by a mechanical draftsman; 16 years' experience in Corliss steam air compressors, gas and gasolene engines; A-1 references. Box 816, AMER. MACHINIST.

Salesman; have good electrical and mechanical experience; drafting, etc. 5 years, 4 years' shop; London University technical graduate; age 27; wish to gain experience in salesmanship; some previous experience. Box 810, AMERICAN MACHINIST.

Factory accountant—Practical man on machine shop and foundry costs; also first-class bookkeeper and systematizer; desires position with manufacturing concern; modern methods and satisfactory results guaranteed. Box 821, AMERICAN MACHINIST.

OHIO

Mechanical engineer wants change; technical graduate; 10 years' experience in machine shop and drafting room. Box 824, AMERICAN MACHINIST.

Expert cost accountant; young man, at present manager of the department of organization and costs of a large audit corporation, desires an executive connection with a large manufacturing concern, who are in need of a thorough, wide awake man with executive ability and wide experience in the manufacturing and foundry lines, and one who will guarantee to lower the cost of production in a large measure; salary can be discussed later. Box 811, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—A general foreman for works manufacturing switches for steam and electric railroads. Box 797, AMER. MACHINIST.

MASSACHUSETTS

Wanted—A superintendent to take charge of a long established manufacturing plant, employing about 250 hands turning out medium and light mechanical apparatus; must be thoroughly up to date, good mechanic, organizer, executive, aggressive and all other qualifications to produce the best possible results; good, permanent position for the right man. Box 796, AMERICAN MACHINIST.

NEW YORK

Wanted—Mechanical draftsman familiar with mixing and kneading machinery for bread doughs, chemicals, paint, etc.; to a man thoroughly conversant with this line of machinery, we can offer a good position; state age, experience, if married or single, and salary expected. Address "Mixers," AM. MACH.

OHIO

PENNSYLVANIA

Wanted—First-class tool and die maker who thoroughly understands sub-press dies, etc, to take charge of tool and die department in adding machine and typewriter manufactory. Box 803, AMERICAN MACHINIST.

Wanted—Young man familiar with the friction clutch and pulley business as salesman; give full details of past experience, length of engagements, salary received and expected; clutch department. Box 812, A. M.

WISCONSIN

Assistant superintendent with experience in manufacturing the highest grade of machine tools (preferably milling machines); a man with a thorough knowledge of accuracy requirements and understanding how to attain it at least cost; must be capable of handling details and have executive ability; state age, experience and salary expected. Kearney & Trecker Co., Milwaukee, Wis.

Draftsman with experience in designing machine tools for the market and the necessary jigs and fixtures to manufacture them accurately and economically; a man capable of doing original work—no copier wanted; must understand modern drawing room practice and filing systems; state age, experience and salary expected. Kearney & Trecker Co., manufacturers of milling machines, Milwaukee, Wis.

FOREIGN

Konstrukteur für Vorrichtungen und Fabrikationseinrichtungen von grosser Berliner Maschinenfabrik gesucht. Erforderlich sind reiche Erfahrungen im Vorrichtungsbau, sowie die Fähigkeit, mehrere jüngere Kräfte zu überwachen. Bevorzugt werden Bewerber, die schon ähnliche Stellungen innehatten und längere Praxis im Werkzeugmaschinenbau besitzen. Offerten mit Bildungsgang, Zeugnisabschriften, Gehaltsansprüche und Eintrittstermin unter J. B. 9758. befördert Rudolf Mosse Annoncen-Expedition, Berlin, S. W.

For Sale

For Sale—Foundry, wood and iron machine shop; all equipped. Box 74, Albion, N. Y.

For Sale—Well equipped general machine shop in New Jersey; employing 15 to 20 hands; good reason for selling. P. O. Box 1216, New York City.

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For Sale—Cyclopedia for modern shop practice, four volumes; bound in green morocco leather. Practically new; cost $18; will sell for $6. Address "L. N. O.," Box 425, Chicago, Ill.

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Neptune Meter Co., Long Island City, N. Y.
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Farrel Fdry. & Mach. Co., Ansonia, Conn.

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Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Cammel, Laird & Co., New York.
Carpenter Steel Co., Reading, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
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Chains, Driving
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Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Skinner Chuck Co., New Britain, Conn.
Union Mfg. Co., New Britain, Ct.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, Ohio.
General Electric Co., New York.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hammacher, Schlemmer & Co., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Le Count, Wm. G., So. Norwalk, Conn.
Starrett Co., L. S., Athol, Mass.
Tudor Mfg. Co., Taunton, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.
Cowanesque Valley Iron Wks., Cowanesque, Pa.
Eastern Machinery Co., New Haven, Conn.
Evans Friction Cone Co., Newton Centre, Mass.

Clutches, Friction—*Cont.*
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.

Clutches, Magnetic
Electric Controller & Supply Co., Cleveland, O.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Collets and Attachments, Spring
Adjustable Collet Co., Cleveland, Ohio.

Compound, Core
Obermayer Co., S., Cincinnati, O.

Compound, Pipe Joint
Dixon Crucible Co., Joseph, Jersey City, N. J.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Cambridge, Mass.
Bury Compressor Co., Erie, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Blaisdell Machinery Co., Bradford, Pa.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Newton Centre, Mass.

Connecting Rods and Straps
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Cambridge, Mass.
Cell Drier Machine Co., Taunton, Mass.
Ingle Machine Co., Rochester, N. Y.
Manville Bros. Co., Waterbury, Conn.
Merritt, Jos., Hartford, Conn.
Turner Mach. Co., Danbury, Ct.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, O.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Conveyors, Automatic
Link-Belt Co., Philadelphia, Pa.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Corundum
See Grinding Wheels.

Cotters
Adjustable Collet Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Machinery
Veeder Mfg. Co., Hartford, Ct.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders Iron Foundry, Providence, R. I.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Norton Grinding Co., Worcester, Mass.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction
Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Evans Friction Cone Co., Newton Centre, Mass.
Gisholt Mach. Co., Madison, Wis.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.

Cranes
Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co. New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Bethlehem Steel Co., So. Bethlehem, Pa.
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Lunkenheimer Co, Cincinnati, O.
Winkley Co., Detroit, Mich.

Cups, Grease
Lunkenheimer Co., Cincinnati, O.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros. ,Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Nash Company, Geo., New York.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Manning, Maxwell & Moore, Inc., New York.
Newton Mach. Tool Wks., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schmitz, August, Dusseldorf, Germany.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.

Cutting-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Globe Machine & Stamping Co., Cleveland, O.
Manville Bros. Co., Waterbury, Conn.

Dies, Sub-Press
Sloan & Chace Mfg. Co., Newark, N. J.

Dies, Sub-Press—*Continued.*
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Alteneder & Son, Theo., Philadelphia, Pa.
Artisans Guild, Benton Harbor, Mich.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.

Drawing Materials
Alteneder & Son, Theo., Philadelphia, Pa.
Keuffel & Esser Co., New York.
Kolesch & Co., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Boiler
American Tool Works Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co. New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Electric
Chicago Pneumatic Tool Co., Chicago, Ill.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark, Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Drilling Machines, Multiple Spindle—*Continued.*
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Ct.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Dreses Mach. Tool Co., Cin., O.
Fitchburg Machine Works, Fitchburg, Mass.
Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hoefer Mfg. Co., Freeport, Ill.
Kern Machine Tool Co., Cincinnati, O.
Knight Machry. Co., W. B., St. Louis, Mo.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.

Drilling Machines, Upright—*Continued.*
Whitney Mfg. Co., Hartford, Ct.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton -Air Compressor Works, New York.

Drills, Rail
Foote-Burt Co., Cleveland, O.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Cleveland Twist Drill Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder
Graham Mfg. Co., Providence, R. I.

Drying Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos
Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker - Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Co., Belleville, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. & Co., Chicago, Ill.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincin., O.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrical Supplies
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crocker - Wheeler Co., Ampere, N. J.
Electric Controller & Supply Co., Cleveland, O.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sprague Elec. Co., New York.
Triumph Electric Co., Cincin., O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Western Electric Co., Chicago, Ill.

Machine Department

Chain Department

Miscellaneous Department

We are now well settled in our New Factory and

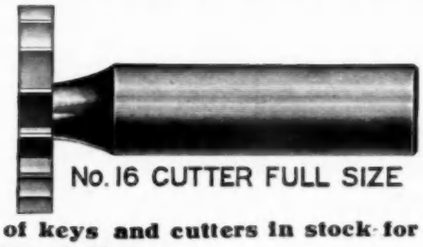
Ready to Show Results

Prompt Delivery and Constant Improvement in Quality

In our effort to possess the Finest Chain Plant in existence and to maintain the highest degree of Accuracy, Efficiency and Finish we are going to the very limit.

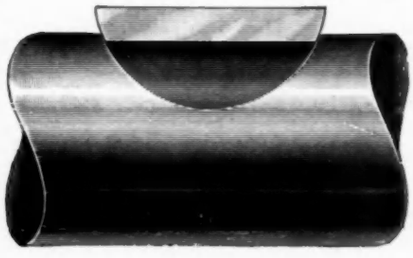
We will now make all sizes of Roller and Bushing Chains for which there is a reasonable demand.

"WHITNEY" MACHINE KEYS and KEY-SEAT CUTTERS
(For the Woodruff Patent System of Keying)

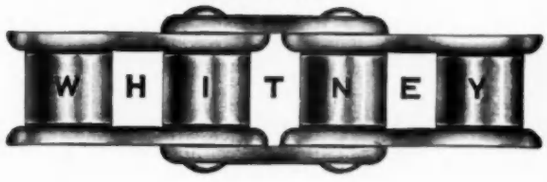


No. 16 CUTTER FULL SIZE

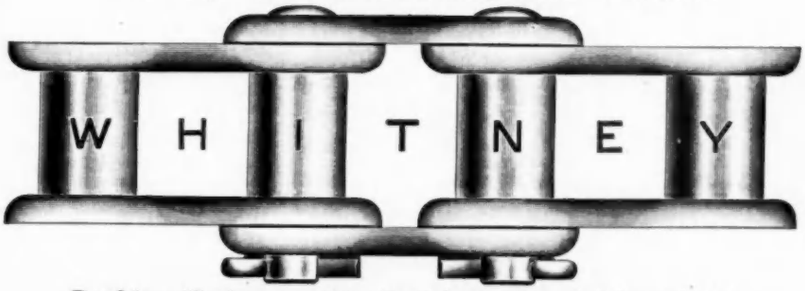
We carry 95 regular Sizes of keys and cutters in stock for immediate delivery.



Roller Chain



"Whitney" Detachable Bushing Chain—Patented



Bushing Chains are like Roller Chains—Without Rolls

The Whitney Mfg. Co.

Hartford, Conn.

Electrical Supplies—*Cont.*
Weston Elec. Instrument Co., Newark, N. J.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Electric Controller & Supply Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cincin., O.
Manning, Maxwell & Moore, Inc., New York.
Roth Bros. & Co., Chicago, Ill.
U. S. Electrical Tool Co., Cincinnati, O.
Western Electric Co., Chicago, Ill.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Co., Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
American Emery Wheel Co., Providence, R. I.
Bay State Stamping Co., Worcester, Mass.
Desmond-Stephen Mfg. Co., Urbana, O.
Diamond Saw & Stamping Works, Buffalo, N. Y.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Vitrified Wheel Co., Westfield, Mass.
Wrigley Co., Thos., Chicago, Ill.

Enclosures, Tool-room
Hart & Cooley Co., New Britain, Conn.
Merritt & Co., Philadelphia, Pa.

Engineering Appliances
Crosby Steam Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Engineers, Mechanical and Electrical
Crocker - Wheeler Co., Ampere, N. J.
Merritt, Jos., Hartford, Conn.
Seaver, John W., Cleveland, O.

Engines, Gas and Gasolene
Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Olds Gas Power Co., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

Engines, Motor
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Ridgway Dynamo & Engine Co., Ridgway, Pa.

Engines, Steam
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition, Machinery
Philadelphia Bourse, Phila., Pa.

Expanders, Tube
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Eyelet Machinery
Manville Bros. Co., Waterbury, Conn.

Factory Equipment
Lyon Metallic Mfg. Co., Aurora, Ill.
Mfg. Equipment & Eng. Co., Boston, Mass.

Fans, Electric
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., Phila., Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Files and Rasps
American Swiss File & Tool Co., New York.
Barnett Co., G. & H., Phila., Pa.
Carver File Co., Philadelphia, Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichheim & Co., E. P., New York.

Filler, Iron
Clark Cast Steel Cement Co., Shelton, Conn.
Felton, Sibley & Co., Phila., Pa.

Filing Machines
Cochrane-Bly Co., Rochester, N. Y.
Henry & Wright Mfg. Co., Hartford, Conn.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Burke Machy. Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, O.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop
Bethlehem Steel Co., So. Bethlehem, Pa.
Billings & Spencer Co, Hartford, Conn.
Bullard Auto. Wrench Co., Providence, R. I.
Crescent Forgings Co., Oakmont, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Williams & Co., J. H., Brooklyn, N. Y.

Forgings, Hydraulic
Bethlehem Steel Co., So. Bethlehem, Pa.

Forgings, Steel
Bethlehem Steel Co., So. Bethlehem, Pa.
Cammel, Laird & Co., New York.
Crescent Forgings Co., Oakmont, Pa.
Tindel-Morris Co., Eddystone, Pa.
Witteman & Co., A. P., Philadelphia, Pa.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Goldschmidt Thermit Co., New York.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co, Chicago, Ill.
Nash Company, Geo., New York.
Tate, Jones & Co., Pittsburg, Pa.

Furnaces, Annealing and Tempering—*Continued.*
Westmacott Gas Furnace Co., Providence, R. I.
Witteman & Co., A. P., Phila., Pa.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Gas
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Nash Company, Geo., New York.
Obermayer Co., S., Cincinnati, O.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting
American Gas Furnace Co., New York.
Nash Company, Geo., New York.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Oil
Tate, Jones & Co., Pittsburg, Pa.

Furniture, Machine Shop
Hart & Cooley Co., New Britain, Conn.
Lyon Metallic Mfg. Co., Aurora, Ill.
Manufacturing Equip. & Engineering Co., Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gages, Recording
Bristol Co., Waterbury, Conn.

Gages, Standard
Ames & Co., B. C., Waltham, Mass.
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Grönkvist Drill Chuck Co., Jersey City, N. J.
Henry & Wright Mfg. Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Wks., Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.
Wyke & Co., J., East Boston, Mass.

Gages, Steam
Bristol Co., Waterbury, Conn.
Crosby Steam Gage & Valve Co., Boston, Mass.

Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., New York.
Morse, Williams & Co., Phila., Pa.
Newton Machine Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.

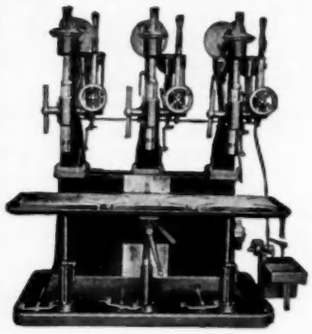
Gears, Cut
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros Gear & Machine Co., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Wks., Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
Morse, Williams & Co., Phila., Pa.
Mutual Machine Co., Hartford, Conn.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waterbury Gear Co., Waterbury, Conn.

Gears, Molded
Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Horsburgh & Scott Co., Cleveland, Ohio.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Rawhide
Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Earle Gear & Mach. Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.

Gears, Worm
Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., Cleveland, Ohio.
Morse, Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton, Cleveland, O.

Generating Sets
Burke Electric Co., Erie, Pa.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electric Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, O.



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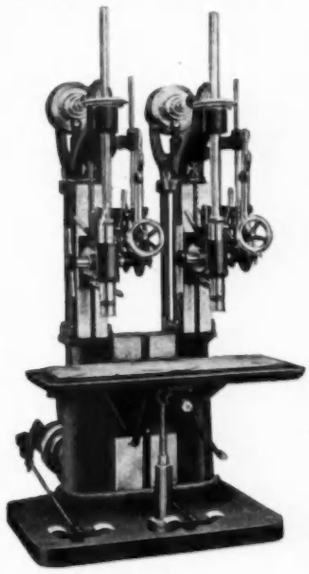

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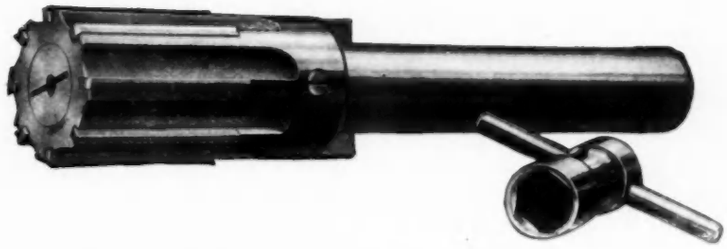

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Hisey-Wolf Mach. Co., Cin., O.
Mueller Machine Tool Co., Cincinnati, O.
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Bath Grinder Co., Inc., Fitchburg, Mass.
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Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
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Garvin Machine Co., New York.
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Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
Manning, Maxwell & Moore, Inc., New York.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Dock Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical
Bath Grinder Co., Inc., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk
Bath Grinder Co., Inc., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Diamond Machine Co., Providence, R. I.
Gardner Machine Co., Beloit, Wis.
Heald Mach. Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Taylor & Fenn Co., Hartford, Ct.

Grinders, Drill
Heald Mach. Co., Worcester, Mass.
Manning, Maxwell & Moore, Inc., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, Ohio.

Grinders, Drill—*Continued.*
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal
Bath Grinder Co., Inc., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Rivett Lathe Mfg. Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, O.

Grinders, Portable
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach, Co., Cincin., O.
U. S. Electrical Tool Co., Cin., O.

Grinders, Saw
Tindel-Morris Co., Eddystone, Pa.

Grinders, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Inc., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co, Providence, R I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Diamond Machine Co., Providence, R. I.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Manning, Maxwell & Moore, Inc., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Mummert, Wolf & Dixon Co., Hanover, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cin., O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding or Polishing Machinery
Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Inc., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Burke Machy. Co., Cleveland, O.
Chicago Machine Tool Co., Chicago, Ill.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark, Jr., Elec. Co., Inc., Jas., Louisville, Ky.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker - Wheeler Co., Ampere, N. J.
Diamond Machine Co., Providence, R. I.

Grinding or Polishing Machinery—*Continued.*
Gardner Mach. Co., Beloit, Mich.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machry. Co., Chicago, Ill.
Monarch Emery & Cor. Wheel Co., Camden, N. J.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Safety Emery Wheel Co., Springfield, O.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.

Grinding Wheels
Adams Co., Dubukue, Iowa.
American Emery Wheel Co., Providence, R. I.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Diamond Machine Co., Providence, R. I.
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Norton Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames
Athol Machine Co., Athol, Mass.
Cleveland Stone Co., The, Cleveland, O.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.

Gun Barrel Machinery
Diamond Machine Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.
Reed Co., F. E., Worcester, Mass.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
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Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., Chicago, Ill.
Clayton Air Compressor Works, New York.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sampson & Co., Geo. H., Boston, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power
Beaudry & Co., Inc., Boston, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Hammers, Steam
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Manning, Maxwell & Moore, Inc., New York.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.

Hammers, Steam—*Continued.*
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Handles, Machine Tool
Whitman & Barnes Mfg. Co., Chicago, Ill.

Hangers, Shafting
Link-Belt Co., Philadelphia, Pa.

Heaters, Feed Water
Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hobbing Machines, Worm
Gould & Eberhardt, Newark, N. J.
Pratt & Whitney Co., Hartford, Conn.

Hoisting and Conveying Machinery
Brown Hoisting Machinery Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Link-Belt Co., Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Niles-Bement-Pond Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Yale & Towne Mfg. Co., New York.

Hoists, Electric
C & C Electric Co., New York.
Case Mfg. Co., Columbus, O.
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker - Wheeler Co., Ampere, N. J.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Electric Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Sprague Electric Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Hand
Case Mfg. Co., Columbus, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Moore Co., Franklin, Winsted, Ct.
Nicholls, Wm. S., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic
Chicago Flexible Shaft Co., Chicago, Ill.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Northern Engineering Works, Detroit, Mich.

Hones
Carborundum Co., Niagara Falls, N. Y.
Chicago Pneumatic Tool Co., Chicago, Ill.

Hose
Chicago Pneumatic Tool Co., Chicago, Ill.
Rhoads & Son, J. E., Phila., Pa.
Sprague Electric Co., New York.

Igniters, Gas Engine
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Indicators, Speed
Warner Instrument Co., Beloit, Wis.

Indicators, Steam Engine
Crosby Steam Gage & Valve Co., Boston, Mass.

Indicators, Test
Grant Mfg. & Mach. Co., Bridgeport, Conn.